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ABSTRACT

Current issues in educational communications and technology are addressed in this collection of 35 papers, in which research reports predominate. Topics discussed include factors related to the learner, e.g., field dependence/independence, reading ability, learning strategies, and cognitive style. Presentation format and media and stimulus characteristics are also addressed, including information cueing, color realism, aptitude sensitive instruction, advance organizers, visual testing, and imagery form. Several papers examine innovative educational media such as teleconferencing, videotapes, and microcomputers. Additional papers discuss the use of fear in persuasive messages, design of instructional visuals, visualization, patterns for mapping cognitive structure, task analysis, naturalistic inquiry as a research methodology, aptitude treatment interaction research, brain research, and nonverbal communication. References and data tables are included with many papers. Cumulative indexes of authors and descriptors covering the first five AECT conference proceedings volumes (1979-1983) are provided). (LMM)

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PREFACE

For the fifth year, the Research and Theory Division of the Association for Educational Communications and Technology (AECT) is publishing these *Proceedings*. Papers published in this volume were presented at the national AECT Convention in New Orleans, LA. A limited quantity of this volume were printed and sold. It is also available on microfiche through the Educational Resources Information Center (ERIC) system.

REFEREEING PROCESS: All Research and Theory Division papers selected for presentation at the AECT Convention and included in this *Proceedings* were subjected to a rigorous blind reviewing process. Proposals were submitted to Dr. Barb Grabowski of the University of Maryland who coordinated the review process. All references to author were removed from proposals before they were submitted to referees for review. Approximately sixty percent of the manuscripts submitted for consideration were selected for presentation at the Convention and for publication in these *Proceedings*. The papers contained in this document represent some of the most current thinking in educational communications and technology.

For the first time this volume contains two cumulative indexes covering the first five volumes, 1979-83. The first is an author index. The second is a descriptor index. The two indexes will be updated in future editions of this *Proceedings*.

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TITLE: The Nature of Learners As Total Systems With Implications For Research and Instructional Development: A Theoretical/Conceptual Paradigm

AUTHOR: Don Beckwith

The Nature of Learners As Total Systems
with Implications for Research and Instructional Development:
A Theoretical/Conceptual Paradigm

Don Beckwith
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Presented at
the annual convention of
The Association for Educational Communications and Technology
New Orleans, Louisiana
January 1983

Introduction

As a profession we have addressed the identification of learner characteristics as essential variables to be considered in both the instructional development for and research of the learning process. We have looked at learner analysis as part of the needs assessment procedure (Kaufman, 1976); learner aptitudes linked to instructional treatments (Cronbach & Snow, 1977, 1981; Solomon, 1979); learner attitudes (Simonson, 1979, 1980); the learner's process during learning (Ausubel, 1978; Briggs & Gagne, 1979; Merrill, 1978; Winn, 1982); learner styles and preferred modalities (Ausubel, 1978; Dunn, Dunn & Price, 1977; Entwistle, 1977; Foley & Smilansky, 1980; Marton & Saljo, 1976; Mos, et al, 1974; Pask, 1976; Ross, 1980). We have called for research and development models that reflect and are appropriate to the practice of education (Becker, 1977; Clark, 1979; Shulman, 1970); and for research and development paradigms and methodologies that address the whole learner as a total system (Beckwith, 1980; Clark, 1980; Torkelson, 1980; Winn, 1975).

Problem

Little, however, has been offered conceptually or theoretically to suggest an operational definition of the learner as a total system. Beyond a mere summing of all aptitudes, traits, characteristics, processes, attitudes, styles, and modalities - what is a total system learner? How does s/he behave? How does s/he respond to external variables? How does s/he respond to intervention? What is his/her motivation for learning? What are his/her predominant strategies for systematically and/or systemically processing, storing, and retrieving information? What learning environments are most condusive to his/her learning? Are all learners total systems?

Or are there learner stages or levels from nonsystem, to emerging system, to total system, and perhaps beyond? Are all total system learners the same type of system? Or do learners represent a variety of systems, such as natural, synergystic, purposeful, self-regenerative?

Purpose

This paper offers a conceptual/theoretical model of the learner representing four distinct categories of total system realization. It is hoped that the model, after significant further testing, may serve as a theoretical base for innovative, learner-centered instructional development and research methodologies.

Definition of System

Before discussing the learner as a total system it might be wise to explore the term "system". From our scientific/biological tradition we have labeled as system that which, made up of related components, works to effect and maintain survival -survival of an individual as an individual, a species as a species, or a relationship between individual and/or species. This type of system takes the form of a natural phenomenon; biological systems, cybernetic systems, ecological systems are all examples, each seeking first, foremost, and last to maintain themselves. These systems are largely reactive, waiting for an intrusion, the introduction of a foreign or disturbing element or incompatible interface, and then reacting in such a way as to bring the system back - as closely as is possible - to its original state. A reactive biological system, for example, may produce such as el dope to relieve itself of stress, pain, and anxiety, and to aid return of the body to its normal state. A reactive psycho-cybernetic system may create rationalizations to protect the psyche from verbal attack from outside the system, again trying to maintain the comfortable balance that epitomizes the reactive system. A reactive ecological system, as a reaction to flood or fire, might generate new plant life in the new-found space. In all cases the goal of the reactive system, i.e., natural system, seems to be that of survival through maintenance-seeking balancing.

The attributes of the reactive/natural system have been applied in many areas of our technological society; we have created man-made reactive systems -emulating nature's reactive systems - systems that have as their sole purpose for existing the maintenance of equilibrium. A thermostatically-controlled furnace, for instance, will bring itself back to "normal" when it is temporarily out of balance.

Also from our scientific tradition we have labeled as system that which has a whole that is greater than a summing of its component parts. This synergystic way of looking at system implies an awareness of a goal beyond the system itself. The synergystic system is *preactive*, i.e., while its goal may be the same as that of a reactive system - maintaining equilibrium - it seeks something outside of itself, something that cannot be pre-defined, to raise the quality of system existence to a higher level. The preactive system may be seen as an exploratory, problem-solving approach, an approach that provides the promise of the primed/aided evolution to a more effective and efficient system existence. The preactive system, like the reactive system, has a goal, but the goal of the preactive system is more adventuresome, reaching out somewhat into the vast unknown, hoping to find a more rewarding level of maintenance, while clinging with one hand to the security of the known and still alive reactive. Using the reactive system as a base, the preactive system may explore potential system components, react to each, incorporate some, and by so doing evolve to a higher order. The willingness to evolve, much more so than the desire for a particular kind of goal of evolution seems to be a key ingredient of the preactive system. The process is deemed more important than the product, hence appropriate goals for preactive systems are simply stated in terms of betterment, higher quality.

Examples of preactive systems abound in the social and political spheres. An energy program, an anti-nuclear movement, a political structure - all have the essential ingredients of a preactive system, i.e., a goal stated in terms of betterment, beyond equilibrium maintenance, but very much within the security framework of equilibrium maintenance; system components that have the potential for creating a whole that is greater than the sum of its parts. The preactive system must move beyond the status quo to a state of higher quality.

Yet another system emerges from our scientic tradition - the dynamic purposeful system - a system which has a clearly established goal beyond its current confines (boundaries) and marshalls interactions and interrelations among and between its current and potential components in order to attain that predefined goal. This *proactive* system epitomizes the system approach of problem solving; examples can be found in the likes of such as PPBS, PERT, instructional design and development, management by objectives. The key element that sets the proactive system apart from the preactive system is that the proactive system has as its focus (target) a clearly defined goal outside of the current system, whereas the preactive system has a rather generally defined goal that suggests a betterment of the existing maintenance goal. While the preactive system exists to effect a higher quality level of maintenance, the proactive system exists to solve specified problems.

A fourth system exists as a type of self-regenerative entity, a system whose means and ends are not separated, but rather are fused as one. Different from the proactive system's endless series of goal setting-goal attainment, this *spiralling* system maintains a constant state of goal realization. The goal is the system; the system is the goal. The spiralling system, thus, grows at a rapid rate, using an almost intuitive process to increase and improve its purposeful value structure. The spiralling system is its own epitome. Examples can be found in those individuals and institutions that operate at the characterization level of the affective domain.

The term "system" has been used widely and variously. The four types of systems discussed above all meet any definition of system; they all have goals, they all depend upon interrelations and interdependencies of components, and they are all dynamic in their structure. The difference lies in the relation of the goal to each system; in a preactive system the goal is related to the output of the system; in a reactive system the goal is related to the status quo; in a proactive system the goal is related to the outcome of the system; and in a spiralling system the goal is the system. (See Figure 1.)

PLACE FIGURE 1 ABOUT HERE

The Learner As System

The following theory is based upon four years of preliminary, constructionist research, with secondary, undergraduate, graduate, and post-doctoral learners in the U.S., Scotland, and Egypt.

Many educators over the years have referred to the learner as a total system and/or have urged other educators to look at learners as systems. But what type of system? Reactive, preactive, proactive, or spiralling? Might there indeed be learners who fall into each of the four system categories? Might there be a continuum from low-ability to high-ability learning within each learner system? I suggest there might.

For this preliminary discussion of the four learning systems, each learning system will be presented in its optimum form, i.e., the learner system as epitomized by the high-ability learner. In later discussion low- and middle-ability learner performance will be presented.

The Reactive Learner

Having an internal goal of status quo maintenance and equilibrium-seeking, the reactive learner is a system in the biological, cybernetic, ecological, and natural senses of the word. The reactive learner is made up of those unrelated components that happen to exist within, at a given point in time. In such a system when one component changes, it does not have a predictable, purposeful effect on all other components within the system; there is not the focused interrelationship of components, nor the purposeful, meaningful interdependency, nor an external goal. Rather than being a purposeful, meaningful whole, the reactive learner is an amalgamation of shifting, vascillating attributes - an amalgamation of components that happen to be existing within a given organism, the sole function of which is to maintain existence. This system is reactive; all input from the outside is reacted to in terms of equilibrium-seeking, the maintenance of non-directed equilibrium.

Motivation

Since the reactive learner is most comfortable in familiar surroundings, i.e., within the natural system he finds himself in, s/he tends to cling to the status quo and avoid change. The reactive learner, uncomfortable with not knowing, anxious with cognitive dissonance, and frustrated with lack of closure, seeks convergent answers, concrete "truth", and gap-filling knowledge in order to maintain his/her equilibrium and to keep things smooth, untroubled, and anxiety-free. The overwhelming motivation for learning is survival as a student, the staying off of the pain of failure. The reactive learner is a naturally adaptive being, adjusting to new information in order to maintain the status quo; s/he has an unconscious desire to maintain the equilibrium; s/he exists to exist; his/her raison d'etre is survival pure and simple. A hedonistic, comfort-seeker, the reactive learner reacts to new information by absorbing it; the comfort that comes with "knowing", quickly and painlessly, keeps this reactive process alive.

Behavioral Manifestations

Response to External Variables

The reactive learner is organized to receive information, in boundless amounts. Part of his/her survival mechanism is structured to receive any and all new information, to store this information so that it may be retrieved as received and stored. This part of the ecological system is ready to absord all aspects of information presented. Reactive learning is an intuitive process, an unthinking process, absorbing information, as encountered, until the learner feels temporarily comfortable. The process goes something like this: Information is encountered; a gap in the system (i.e., the lack of the information encountered) is realized by the learner; information is absorbed in order to fill the gap. (See Figure 2.)

PLACE FIGURE 2 ABOUT HERE

Thus the absorbtion of new information is dependent solely upon the perceived existence of gaps in the learner's information storage. Successful learning for the reactive learner is defined, unconsciously, in terms of closure as each learned bit of information is sealed off, stored, ready for retrieval exactly as stored, unaffected by time, other stored information, or life experiences.

Regardless of the amount of information received and stored, the storage system remains one of purposeless amalgamation of learned components forever vascillating and shifting, floating unattached, retrievable only by set cues and paired associates. In the absence of internal analysis of external stimuli, the acceptance of new information appears to be random and incidental.

Since the new information is stored as received, the evidence of synthesized (or related) information is only apparent if the information was so synthesized (or related) when received. By the same token, if such as examples and/or nonexamples of a concept are received with the concept, they are stored together with the concept. Otherwise, the learned components are merely disassociated bits, coexisting, never being synthesized until a significant other provides the relationship, which is then stored as this particular relationship only.

The learning goals of the reactive are short term - to master the information at hand by maintaining each information bit (whether a memorized fact, concept, or principle) within and by itself. So while the contents in storage are ever changing, the change is incidental rather than purposeful.

The reactive learner, thus, is solely dependent upon the external information supplier for facts, opinions, solutions to problems, examples and nonexamples of concepts and principles, arguments, rationales, justifications, thoughts, etc. S/he has no real control over external variables. And the control over the variables, once they become internalized, is limited to the maintenance of a static storage/retrieval mechanism. Resultingly, s/he has a tendency to label all stored information as truth or right answers, worthy of being learned and stored for future retrieval.

Since, as a survival mechanism, reactive learning can be effective in most traditional learning environments, its application is not limited to the very young, but rather can be found as an operating system in any learner who enjoys learning by passively receiving, storing, and retrieving unchanged information. Through this learning process the reactive learner may exist as an ecological system, operating from and responding to the maintenance of internal equilibrium.

Response to Intervention

As long as new information is passively encountered, i.e., not forced upon the reactive learner, the ecological adjustment is not so very difficult, a fairly simple matter of filling gaps only where gaps are perceived. The reactive learner, seeking continual peace and harmony, is not likely to perceive a gap if the new information differs from or disagrees with the existing stored information in the same category. Thus cognitive dissonance is kept to an absolute minimum.

In formal learning environments, however, this control of external variables - by exclusion - is very seldom possible. Time and time again new information is presented which disagrees with stored "truth". When such discordant (contradictory) information is encountered by or introduced to the reactive learner, it is usually either (a) rejected out of hand, especially if the information supplier is seen to be less of a significant other than the supplier of the original stored information; (b) denied and then, for survival purposes, merged, side by side, with the stored information, without any mental attempt to resolve contradictions; or (c) rejected, temporarily, to minimize the anxiety that accompanies the thought of change or the realization of not having truth, and then is used to replace, in toto, the stored information. (This usually occurs when the new supplier has significant status - by his/her authority or even by his/her proximity, time and/or distance). The initial response seems usually to be one of bewilderment, a sense of not knowing how to respond to the contradictory information; a fight-flight response usually follows. This can be seen as a maintenance, equilibrium-seeking reaction, a comfort seeking. At times, however, due largely to the overwhelming strength and validity of the significant other (information supplier), the stored information is replaced by the new information without the learner's conscious awareness.

As mentioned earlier, the information bits are stored separately, with relations between bits tending to remain unexplored by the learner. If, however, the information supplied includes exposited relationships between bits, these too are stored, intact, by the reactive learner. In other words, the way in which new information might be incorporated with stored information must also be provided, lest the integration never take place.

Thus the reactive learner's response to intervention (of information contradictory to stored information) is one of initial rejection/denial, followed by parallel acceptance; or rejection of old, replaced by new; or total rejection.

Predominant Strategies

The reactive learner is very good at memorizing the spoken and written word as well as gestures, body language, and other non-verbal cues. Most comfortable surrounded by mentors from which s/he may extract "truth", without having to apply logical thought processes, without having to explore the unknown through inquiry/questioning strategies, the reactive learner seeks predigested, thought-through truth. By using this strategy, he/she is able to store, as fact, each bit of information (whether it be hypothesis, generalization, example, or defined concept), thereby facilitating the retrieval of each isolated information bit through the use of paired associates, mnemonic cues and the like. Retrieval is facilitated further through the strategy of storing only one opinion or generalization per issue.

More specifically the reactive learner's strategies include dutiful and prompt class attendance; heavy, verbatim note-taking; textbook dependency; seeking opinions and summaries from experts; preference for a deductive teaching method; early completion of assignments (in order to hasten ecological closure); asking questions for clarification only; asking convergent questions; answering questions convergently; opting for comprehension exercises. These strategies, separately and in combinations, tend to reduce anxiety and frustration and enhance equilibrium maintenance.

While the reactive individual may be quite a keen learner, able to absorb large quantities of information and retrieve the quantities with ease, the nature and scope of his/her learning is certainly limited.

Successful Learning Environments

The most successful learning environment for the reactive learner is that of the student-mentor relationship, wherein the mentor passes on the tablets of wisdom to the learner who dutifully stores them for future retrieval. The more highly structured this process of information transfer the more comfortable the reactive learner will be. Tutorials and lectures are preferred over seminars and independent investigations; short lists of required readings are preferred over long lists of recommended readings; frequent knowledge-comprehension level assessments are preferred over term papers and examinations that assess the higher levels of cognition. In general, those environments which promote ecological system maintenance, while keeping cognitive dissonance to a minimum, are sought by the reactive learner.

Summary

Reactive learners are survivors, reacting - unconsciously and intuitively - to external variables and intervention of contradictory information by absorbing or rejecting them as quickly as possible. The only goal is maintenance of an unthreatened ecological system. (See Figure 3.)

Transition

The pressures from peers, authority, social and institutional conventions, and media may alone be enough to enable one to move from reactivity to preactivity, a more sophisticated survival stage. These same types of pressures, however, may be instrumental in aiding transition from reactivity to proactivity or spiralling. (More about this later.) (See Figure 4.)

PLACE FIGURE 3 ABOUT HERE

The Preactive Learner

While the reactive learner is happiest maintaining the equilibrium and status quo, the preactive learner desires to effect a higher level of existence while still attending to the security which comes from equilibrium maintenance. While this desire for an elevated level of existence is apparent, the specifics of the desired level (goal) are not clear. In order to successfully achieve the synergystic goal, the preactive learner relies upon the information suppliers (the significant others of the reactive learner) to become the sole models of learning behavior. By emulating these role models and subjecting him/herself to their criteria for acceptable learner behavior, the preactive learner is able to increase synergystic potential and thus realize a higher, yet unpredetermined level of learning.

While still comfortable as a total ecological system, yet aware of a more desirable system existence, the preactive learner allows him/herself to take a few steps of faith in order to achieve what the role models have achieved. But at the same time s/he clings to the security of his/her reactive system.

The preactive learner, like the reactive learner, is an amalgamation of components. Unlike the reactive learner, the preactive learner has a goal, albeit an unclear, ill-defined goal, but nevertheless a goal - that of emulating a socially acceptable standard. Since s/he consciously and reliably reflects the rules, mores, procedures accepted by his/her society, s/he changes as society changes. To do this, the preactive learner adapts a learning structure that is constant; this structure survives, for that is the goal of the system, to maintain the structure, the structure that will guarantee survival of the system within the society. So the components within the learner may be interrelated, may even, at times, be interdependent, but only to the extent necessary to maintain the externally imposed (society imposed) status quo. The status quo sought by the preactive learner is no longer individually determined, as with the reactive learner, but rather is society-determined. While the survival of the reactive learner is a purely individual matter, the survival of the preactive learner has a social significance. The preactive learner is not a natural phenomenon but rather a man-made system of the synergystic kind.

Motivation

For the preactive learner the strongest motivation is the desire for social acceptance; s/he allows him/herself to be molded by the image of society in order to keep the peace (maintained equilibrium) and stay accepted. In this very comfortable, other-supported and controlled environment, the preactive learner demonstrates the socially acceptable learner behaviors, partially to gain the approval of peers and those in authority, and partially to submit to the control of the prevailing social and institutional conventions. Another strong motivating factor is the desire to reduce the discomfort associated with random, unpredictable reactivity, and to increase the comfort associated with predictable preactivity (by following the tested paths of others).

Since the preactive learner depends upon external forces to provide security and acceptance, s/he finds it difficult, disconcerting, and discomforting to think new thoughts, to step out on a limb, or to set new goals that are beyond the survival goals of the accepted social system.

Behavioral Manifestations

Response to External Variables and Intervention

The preactive learner is aware that the information supplied by the learning environment is being presented as an intervention, aware that the social school structure is intent upon feeding him/her not only content deemed worthy but also learning procedures deemed worthy, these worthy learning procedures being implicit in the way the content is presented. Eager to please and become part of the existing social structure, the preactive learner accepts the content as presented and reacts to it and with it in ways that are expected and accepted by the social system. The preactive learner realizes that s/he is to learn socially approved content in socially approved ways, and obliges quite happily, trying, as s/he is, to receive social approval as well. Trying to fit in with the expectations of others, the preactive learner builds no goals of his/her own. In fact, in order to build his/her own goals, s/he would have to receive guidance (from the social system) for learning the socially-acceptable goal-building procedures and rules. Of course there are no such available procedures, for if learners were to follow such procedures to their desired outcome, the result could spell the demise of the socially accepted structure, the status quo. In fact, the socially accepted procedures for learning the socially accepted content tend to preclude the learner's transcending the existing curriculum and its aims. During preactivity the accepted social conventions are neither questioned nor challenged by the learner; they are, rather, perceived as the "right" answers.

Predominant Strategies

Unlike the reactive learner who often responds in unpredictable ways, depending upon the nature and quantity of stored information compared to the nature and quantity of presented information, the preactive learner responds in very predictable ways, those ways which are known, adhered to, and promoted by the social order. Much time is spent not only using established sets of learning rules and guidelines but also seeking and finding all such rules and guidelines.

While the reactive learner is primarily assimilative, i.e., absorbing all information presented in the form in which it is presented, the preactive learner is primarily accommodative, i.e., adjusting his/her learning strategies to fit the expectations of the social system, following a set of time-tested, other-prescribed rules for successful learning.

Specifically, the preactive learner wants to know exactly what is expected - all of the requirements - and looks for the shortest, easiest way of fulfilling these requirements, using one or more of the many mastered, standard learning strategies accepted by and successful in past educational environments. If and when cognitive conflicts arise, the preactive learner seeks help in resolving apparent contradictions and in seeing potential relationships between stored information and newly-presented information. The preactive learner will often spend much time seeking the "magic" course textbook, the one that has all of the required content presented in the most easily digested format; s/he is uncomfortable having to piece together information from various sources/resources in order to synthesize the course content and structure.

Successful Learning Environments

The preactive learner seems to learn best in traditional learning environments, i.e., teacher directed classrooms. S/he does not like surprises, but rather enjoys being able to master the learning process using the socially-acceptable learning strategies already mastered and oft-time successfully employed. S/he thrives when care has been taken by the teacher to structure the learning environment and course content, when the teacher takes on the accountability for successful learning. In the absence of well-structured teaching, s/he will ask convergent questions of the teacher in order to provide the missing and needed structure. If any evaluation level divergent questions are asked, they serve the purpose of finding out where the teacher stands on any given issue; the teacher's response, of course, is then adopted by the preactive learner as his/her own.

Summary

While many of the equilibrium maintenance behaviors of the reactive learner (operating as a natural system) are present in the preactive learner (operating as a synergystic system), the preactive learner's behaviors are far more conscious and socially acceptable; the "rules" for equilibrium maintenance have become institutionalized, i.e., the individual has adopted the society's mores for learning survival. (See Figure 5.)

Transition

While the preactive learning stage may serve as a transition between reactive learning to proactive learning, preactivity is a very comfortable, other-supported state. Thus it is difficult for the preactive learner to desire and to seek change.

Since the preactive learner looks externally to find security and acceptance, the discomfort brought on by stepping out on limbs, thinking new thoughts, and setting goals precludes most preactive learners from making the transition.

If evolution to proactivity is to occur, the preactive must undergo analysis of the current, at-work learning process so that it may be used as a foundation for, or torn down and replaced by, another. The key to this transition is the conscious development of an outcome- (rather than output-) centered goal. (See Figure 4.)

PLACE FIGURE 5 ABOUT HERE

The Proactive Learner

Unlike the reactive learner who absorbs information as presented or the preactive learner who processes information in socially acceptable ways, the proactive learner assesses the societal (educational environment) goals within the framework of his/her own goals, i.e., s/he lays his/her own criteria over the expected criteria, thus redefining the goal(s) as his/her own. Rather than learning merely to survive (reactive), or to satisfy external criteria and receive external reinforcement (preactive), the proactive learner learns in order to satisfy internal criteria and receive internal reinforcement. The proactive learner, therefore, must be able to conceptualize, think abstractly, feel comfortable while structuring his/her own framework and reinforcement for learning. Furthermore, learner-friendly learning environments are not needed; the proactive is capable of producing his/her own.

Motivation

The proactive learner becomes his/her own significant other, beginning to create his/her own individual learning style, a learning style that is systemic in nature rather than ecological or synergystic. His/her affective leanings are integrated from within, the beginnings of an intrinsic motivation for learning. In setting and trying to achieve his/her own standards, within and/or tangential to goal frameworks presented by or inherent in the educational environment, the proactive learner takes responsibility for his/her own motivation and reinforcement. At times, the self-determined standards are at cross purposes with other-determined standards, resulting in personal satisfaction yet external punishment, e.g., lower grades. The longer the proactive learner adheres to his principles, the easier it is to accept this while maintaining his/her integrity; with increased skill as a proactive learner, s/he is able to integrate, comfortably, all external standards within his internal standards super structure, thus satisfying him/herself as well as society. The resulting societal reinforcers thus become a bonus.

Behavioral Manifestations

Response to External Variables

As external variables come pouring in, the proactive learner integrates this new information easily into his/her goal-directed system, the goal directed system thus facilitating the application of the information in new (self-determined) contexts, contexts sometimes other than those within which the information is embedded when received. During this process of applying information to new goal-directed contexts, s/he becomes more aware of nontraditional information, such as verbal and nonverbal cues, and tends to see courses not so much as entities in and of themselves but rather as parts and potential parts of a greater, self-designed whole; s/he begins to perceive teachers and learning materials as resources rather than as sources. The proactive learner is more open to using external variables as bits to be incorporated (rather than bits already incorporated) than is the reactive or preactive learner.

Response to Intervention

Since the proactive learner's skills are those of purposeful integration, s/he diminishes his/her reliance upon significant others, and increases reliance upon significant self. This often takes the form of challenging accepted procedures of teaching and learning, denying traditional rationales for education, and finding his/her own learning way through the self-creation of goals and attempted attainment of them. He thus resists most, if not all, efforts of external intervention, for s/he perceives the strong connection between the purpose of the external intervention and the external (socially-accepted) goals, goals that are not always consistent with his own. S/he, instead, clings more and more firmly and readily to internal intervention, that which is far more likely to facilitate his own goal attainment.

Predominant Strategies

Since the proactive learner regards self as teacher, s/he indulges in much productive introspection, especially that which concentrates upon goal definition and redefinition and means (both present and potential) for goal attainment. While s/he prefers an inductively structured presentation of new information (for this forces integrated storage, retrieval and application patterns, making full use of his/her systems style) s/he, being quite well aware of his/her own, most efficient, effective, and productive strategies for learning, is able to - through the use of such as high-level questioning, newly created examples, and internal reinforcement techniques - turn even the dullest of deductively presented information into new and exciting grist for his/her hungry mill. Using his/her abilities to receive, store, and retrieve information (from multiple locations) in newly integrated sets, s/he often goes beyond learning expectations, sometimes bypassing these expections entirely. While the proactive learner may serve as a feeder of processed information to the preactive or reactive learner, s/he may use the reactive or preactive learner as a foil against which to test the effectiveness and efficiency of his/her learning system.

Successful Learning Environments

Even though the proactive learner cannot allow himself the easy learning path of the preactive learner, that of accepting what is presented as presented, s/he can thrive in, and most often demands, the same learning environment, but for the proactive it is a learning environment to rebel against, an environment made up of variables just waiting to be separated from each other and resynthesized into something that is personally meaningful. The traditional learning environment becomes an experimental laboratory, a proving ground for the proactive's building of a structured framework for learning. S/he thrives on the dissonance created within, in reaction to the goals and means of the socially accepted environment.

Summary

The proactive learner operates well from a traditional base, providing self-motivation, extracting essential bits from information presented, welding bits from storage and alternative sources, building himself a personalized system to facilitate personalized goals. S/he avoids external intervention, preferring, instead, self-control and reinforcement. (See Figure 6.)

Transition

While it is perhaps more likely for a proactive learner to make the transition to spiralling learner - through the contageous, intrinsic enjoyment that comes from proactive learning, and the need and subsequent searching for ever more control over and gratification from the learning process - it is possible for a proactive learner to have his proactivity stifled (perhaps momentarily) in favor of accepting preactivity (due to strict external enforcement of desired products and processes of accepted learning). The determining factor, of course, will be which of the forces - internal or external - is stronger at the time. (See Figure 4.)

PLACE FIGURE 6 ABOUT HERE

The Spiralling Learner

The spiralling learner has arrived; s/he is a total system. Unlike the proactive learner who has developed a personalized system of learning to be applied according to systemic and systematic principles, the spiralling learner has become his own dynamic, self-regenerative learning system. Aware of his/her constant, upward surge of mental growth (having neither the need, desire, nor the inclination to curb or monitor it) s/he is no longer dependent upon social systems, only upon his/her own self-system. Within his/her totally operative system s/he changes constantly, but realizes that s/he cannot go too fast, is incapable of information overload, sees all constraints as temporary, and feels confident in dealing with new situations and problems; s/he is able to apply the intuition of the reactive learner to successfully ever-spiralling goals and dreams.

Seeing and enjoying him/herself as detached from the traditional, finite systems and as attached to a much larger, altruistic whole, part of infinite systems (across time, space, and depth and breadth of thought), as potential rather than extent, the spiralling learner realizes that there is no end to his spiralling, save through eternity (realized through those generations to follow), realizes that s/he may pass on as many batons as he receives.

His/her altruism takes over. While s/he does not enjoy the company of preactive learners; is seen as a source of anxiety by the reactive learner, as a threat by the preactive learner, and as a model by the proactive learner, s/he feels compelled to help all go beyond their present system of learning, for s/he sees all individuals as having equal potential for making the transition to spiralling learner, and wants all to experience what s/he is experiencing. Therefore, s/he challenges reactives, preactives, and proactives to test their perceptions, notions, beliefs, comforts. Leading systemically rather than systematically, s/he models for proactives, introduces cognitive dissonance to preactives, and provides direct intuitive shortcuts for reactives.

Motivation

Realizing that s/he is part of a larger, altruistic system provides much of the intrinsic motivation needed to keep the spiralling learner going. In addition, s/he hungers for new information, experiences, challenges which will keep his/her spiralling ascending. S/he cannot go back, must move forward; seeing maturation and self-actualization as lifelong processes rather than states to be achieved, s/he dedicates self to a life of integrity and positive change.

Behavioral Manisfestations

Reaction to External Variables and Intervention

For the spiralling learner all things are forever new and fresh; s/he is able to learn from virtually everything, can provide a meaningful context for any and all loose or attached bits of information, and can rapidly appraise and judge any issue within the context of a spiralling system. The external variables and intervention strategies are not merely absorbed, swallowed mindlessly, or reacted against, but rather they are used positively for what they are (and could become) within the total system - the spiralling learner.

Predominant Strategies

Above all, the spiralling learner is resillient, not prone to back down from well thought out positions or to give up goals and dreams; s/he is strong enough to stand up to assault, survive the battle, and emerge stronger and higher on the spiral. Knowing this and feeling the need to spiral higher and higher, s/he will often create his/her own cognitive dissonance (in the absence of other-created dissonant experiences) to ensure and even speed up learning growth. The learning process becomes one of quick and free conceptualization, rapid decision-making with appropriate rationales, all faciliated by the ability to link information bits across time, space and context, and all directed to a constant stream of innovative and altruistic problem solving.

Successful Learning Environments

For the spiralling learner all environments are potentially successful for learning.

Summary

It may be said that so sophisticated is the spiralling learner system that s/he tends to learn in spite of the learning environment, for this learner is able to extract out of context and assimilate into his/her own spiral at a very high level of discrimination, purpose, and rapid rate. (See Figure 7.)

Transition

The spiralling learner is capable of making a temporary, regressive transition to the proactive system. (See Figure 4.)

[illegible]

PLACE FIGURE 7 ABOUT HERE

Summary of Four Learner Systems

The learner may be seen as four distinct systems, reactive, preactive, proactive, and spiralling, each of the four systems meeting the definitional system requirements of being dynamic, having a goal, and having interdependent and interrelated components. The differences lie in the nature of each system's goal and the relation of the goal to the dynamism of the system components. For the reactive learner the goal is internally oriented, survival focused; thus the dynamism is incidental, reacting intuitively to external variables. For the preactive learner the goal is output oriented, focused toward undefined betterment; the dynamism, being externally programmed, is related to the goal attainment process rather than a specified goal product. For the proactive learner the goal is outcome oriented, focused on solving self-predefined problems; the dynamism is thus purposeful, related to goal attainment. For the spiralling learner the goal is value structure oriented, focused on self-regeneration; the dynamism is intrinsically automatic, related to a continued process of spiralling, regenerative goal setting and attainment. (See Figures 1 and 8.)

PLACE FIGURE 8 ABOUT HERE

Just as the goals and dynamism of each learner system are different, so too is the predictability of exhibited behaviors. The reactive learner's behavior is unpredictable; reacting to external variables, the behavior will either be acceptance, denial, or denial and then acceptance (conscious or unconscious). The preactive learner, out to satisfy the social order, may exhibit highly predictable behaviors. The proactive learner's behavior is predictable within the framework of self-established goals, i.e., problems to be solved. The behavior of the spiralling learner, like that of the reactive learner, is unpredictable, for the learning process is very akin to intuition, only the spiralling learner's intuition is purposeful, being affective in spite of the learning environment.

Given their dependence upon the learning environment, the reactive and preactive learners exhibit high anxiety behavior, whereas the proactive and spiralling learners, free from such dependence, exhibit low anxiety behavior.

Transition is possible from some learner systems to others. Transition from reactive to preactive is generally possible through prolonged subjection to a social structure, spurred on by peer, institutional, and social pressures. Transition from reactive to proactive is generally possible through counter reaction to current/predominant social order, spurred by a need for independence and social conscience. Transition from reactive to spiralling is generally possible through intuition, spurred by altruistic feelings and concerns. Transition from preactive to proactive is generally possible through gut-wrenching upheaval, spurred by dissatisfaction with the established order. Transition from proactive to spiralling is generally possible through practice, spurred by internal motivation. (See Figure 4.)

Once a sophisticated learner system, i.e., proactive or spiralling, it is difficult if not impossible for the learner to make the transition to an unsophisticated learner system, i.e., reactive or preactive, even if the existing learning environment/social order is demanding it. Regression from spiralling to proactive or from preactive to reactive is more common, but only as a temporary, security-seeking measure, a reverting to a simpler system when the more complex system demands become overpowering. If there is a natural (i.e., not greatly influenced by external variables) transition from system to system, it seems to occur from the proactive system to the spiralling system. (See Figure 9.)

PLACE FIGURE 9 ABOUT HERE

Levels of Abilities within Learner Systems

Within each learner system category there is, of course, a continuum of learner ability, ability to apply the system to learning. For the sake of discussion, each category may be subdivided into low, middle, and high ability, the high ability being the epitome of each learner system application. Till now the discussion of the four learner systems has been limited to, for the most part, this high ability learner, the premise being that this high ability learner - whether operating as a reactive, preactive, proactive, or spiralling system - may be successful because of and/or in spite of any learning environment. This success does little to promote transition to a different learner system, but rather, makes it very difficult for the learner to change. There may be occasional reversion to an earlier ability or a venture to a new system, depending upon the friendliness or unfriendliness of the learning environment to the existing learner system. The middle and low ability learners, in all four system categories, are far more frequently and easily able to jump to and from ability levels and systems; seeking personal success (whether defined as survival, acceptance, problem-solving, or self-regeneration) the low and middle ability learners are more likely to create new systems of and for themselves.

Given this situation of the high ability learner in any system being reluctant to evolve to another system and the low and middle ability learners willing but not necessarily able to evolve to another system, there are a limited number of viable system shifts that may occur. Obviously, within any one system the learner may shift up and/or down one ability level. The learner may also revert back to any ability level (usually the most successful level) within a former system. For example, the middle ability proactive learner may, as the result of external pressure and the temporary need to be accepted by that external force, revert to a high ability preactive learner. A shift from the high ability level of any system is not always possible to the low ability level of every other system. A high ability preactive learner, for example, may not directly evolve to a low ability spiralling learner, whereas a high ability reactive learner may. It is always possible, however, for a low or middle ability learner in certain systems to shift to a low ability level in another system, for with certain systems the attainment of high learning ability actually inhibits/prevents direct shifts to certain other systems.

Control of Transitions

The learner may, through his/her own efforts alone, engineer one of the possible ability/system shifts. Or the learning environment, through reinforcement, pressure, motivation and/or introduction of skills required for particular shifts, may facilitate the learner shifts. It is also possible, of course, for the learning environment to inhibit or prevent rather than facilitate or make possible certain shifts. For it might be said that learner ability (low, middle, or high) relates to how well the learning environment reflects the present and potential learner systems.

Here lies the rub, for the learning environment may, by its very structure and intent, enhance or inhibit maintenance of a particular learner system at a particular ability level; regression to an earlier learner system/ability level; or shift to a different learner system/ability level. What do learning environments tend to do with this opportunity to enhance or inhibit?

Implications for Instructional Development

It appears that all four learner systems (and all three ability levels within each learner system) can be found in any learning environment. The high ability learners within each system category are, of course, the most successful in any given learning environment, the high ability preactive learner being usually more successful than his/her counterparts in the other three learner system categories. Is the learning environment structured to facilitate and maintain preactive learning and to inhibit and eradicate reactive, proactive, and spiralling learning? Is the instructional development process so intent upon building its own learning environment system that it inadvertently all but precludes the learner's own system development? Are educators so anxious for learners to achieve the goals of the educational system that they forget or overlook the benefit of learners achieving their own goals?

It seems reasonable to suggest that all educators would wish all learners to be spiralling systems, or, at very least, proactive systems. It also seems reasonable to suggest that almost all of our learning environments reinforce preactive learners and discourage and/or punish reactive, proactive, and spiralling learners. It seems that there is quite a gap between the status quo and the ideal. How can educators use the principles of instructional development to close this gap?

With a new ideal - that of all/most learners being proactive or spiralling - problem identification (in the instructional development sense) takes on a much broader perspective; instead of problem statements focusing upon what learners cannot do in terms of demonstratable content/skills mastery (a typical preactive problem statement), problem statements could focus upon learning systems that the learners have not yet become.

So much broader is the latter type of problem statement that it subsumes the intent of and facilitates the attainment of the goals of the former type of problem statement.

Through the needs assessment process the instructional developer might look for evidence of ability level and extant learner system being employed by each learner. In addition, personalized environments that may serve to enhance transition to desired learner systems may be explored by analyzing the learner and his/her goals.

The referent situation and referent situation test could no longer be limited almost entirely to the job market and/or academic achievement, i.e., goals of the extant societal system. Rather, the referent situation must incorporate, if not be dominated by, the yet-to-be proactive and spiralling goals of the learners.

Objectives, instead of being limited to preactive learning, could incorporate development of proactive and spiralling learner systems.

Teaching methods, media, learning activities, and sequencing of objectives could be employed to facilitate transition from unsophisticated learner system to sophisticated learner system, instead of being employed to facilitate transition from reactive to preactive or to facilitate shifts from low to middle to high ability preactive learning alone. (See Figure .) Methods, media, etc. could also be employed to deter/inhibit regression to lower ability levels or from sophisticated to unsophisticated learner system. (See Figure 10.)

PLACE FIGURE 10 ABOUT HERE

Implications for Research

It has been said that with our reductionist approach to research (experimental design) we have ignored the elaborate nature of learners as dynamic, changing individuals (Torkelson, 1980). Is it possible that our research paradigms/methodologies reflect and explore only the preactive learner? Are the mean performances all exhibited by the preactive learner? For the most part, research in education seems to view the learner as being part of an educational system, whether such system be a classroom, subject, course of study/curriculum, or school. We look at the learner's progress in terms of the goals of this educational system, attempting to identify variables which may enhance or inhibit his/her progress in reaching such goals. This could indeed be labeled as a preactive learner research tradition.

Whether we look at research in aptitude-treatment interaction, cognitive styles, or learner attitudes, to name a few of the most recent research thrusts, the emphasis is the same, that of examining the learner as part of a system, i.e., a given educational system, a system dedicated to the preactive learner, who in turn is dedicated to the system. Such research, it seems, even assumes that all subjects are preactive learners, differing only in their preactive learning ability. All learners, however, are not preactive; if they were, we might assume that our research expectations would not be violated, for the preactive learner responds to variables being studied - especially those that have a direct relationship to the accepted societal learning methods that the individual preactive learner has adopted - in very predictable ways.

But our research expectations are violated; our experimental groups include, as well as preactive learners, reactive, proactive, and spiralling learners, none of whom relates to the goals of the educational system, all of whom relate very strongly to their own goals. Because of this, the nonpreactive learner's reaction to external variables are, from a preactive standpoint, unpredictable and ungeneralizable. The reactive learner will absorb or deny external variables in a quest for survival. The proactive learner will use or ignore external variables depending upon their potential usefulness in self-goal attainment. The spiralling learner will use all external variables productively for continued self-regeneration. The nonpreactive learner is not operating within the goal structure of the societal system, but rather s/he is operating in spite of this goal structure, yet through our preactive research designs and questions we are expecting, without realizing it, the nonpreactive learner to behave preactively.

Perhaps it is time to view the educational environment as part of the learner's system. Our research then could look at the educational environment's progress in terms of enhancing or inhibiting the learner's attainment of his/her own goals. What are the variables within the educational environment which inhibit or enhance such goal attainment? How does the learner incorporate external variables into his/her own learner system? This will not be an easy shift to make, for our whole socio-scientific research tradition is based upon the preactive learner model; we strive to learn, to discover, with no predefined goal in mind, but rather merely the goal of more complete understanding of what is (with the underlying belief that such more complete understanding will somehow improve us). By exploring, discovering, and applying (if possible), our preactive research mode keeps alive the synergystic dream that the total of our discoveries will be greater than the sum of its parts. As long as our research efforts are confined to the framework of our own system goals, the answers to such questions as how the learner, especially the nonpreactive learner, represents an experience or perceives during the learning process will remain mystery.

Summary

The results of four years of constructionist research seem to indicate that (1) there are four distinct types of learner systems - reactive, preactive, proactive, and spiralling; (2) ability levels within each of the four types of learner systems; and (3) transitions are possible from some learner systems to some other learner systems. Further, these learner systems do not appear to be developmental in nature, i.e., they do not appear to be natural, ordered stages of learner development. It also appears that some conditions, environments, and/or catalysts may facilitate certain transitions, not only productive transitions, but nonproductive and regressive as well. (See Figures 9 and 11.)

Through instructional development we may wish to structure conditions to facilitate transition from the unsophisticated learner systems (reactive and preactive) to the sophisticated learner systems (proactive and spiralling) and to inhibit transition within the unsophisticated learner systems and from the sophisticated to the unsophisticated systems.

In research we may wish to study the nonpreactive learner system as a total system of which the educational system is but a part.

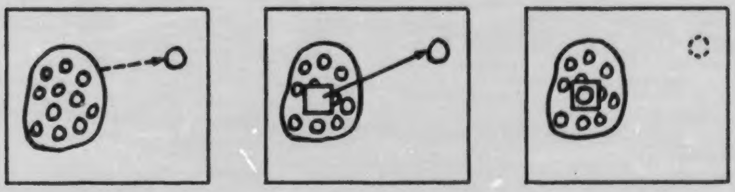
In any case, more research, of course, is needed - research that explores, in nontraditional ways, the nonpreactive as well as the preactive learner system; research that looks at the transitions within and between learner systems; research, in short, that attempts to validate the assumptions inherent within the conceptual/theoretical paradigm presented here.

PLACE FIGURE 11 ABOUT HERE

Figure 1
The Nature of Four Systems

	Goal Relation	Reason for Goal	(Purpose) Type of Interaction and Interrelation of Components	Type of Dynamism
reactive	status quo	maintenance	filling gaps, protecting, mending	reflex
preactive	output	evolution to higher level of quality	seeking, comparing, contrasting, systematic	guided (externally)
proactive	outcome	problem-solving	goal-directed systemic	focused
spiralling	epitomization of value structure	self-regeneration	lateral transfer	intrinsic

Figure 2



encounter gap awareness absorbtion

Figure 3 **The Reactive Learner**

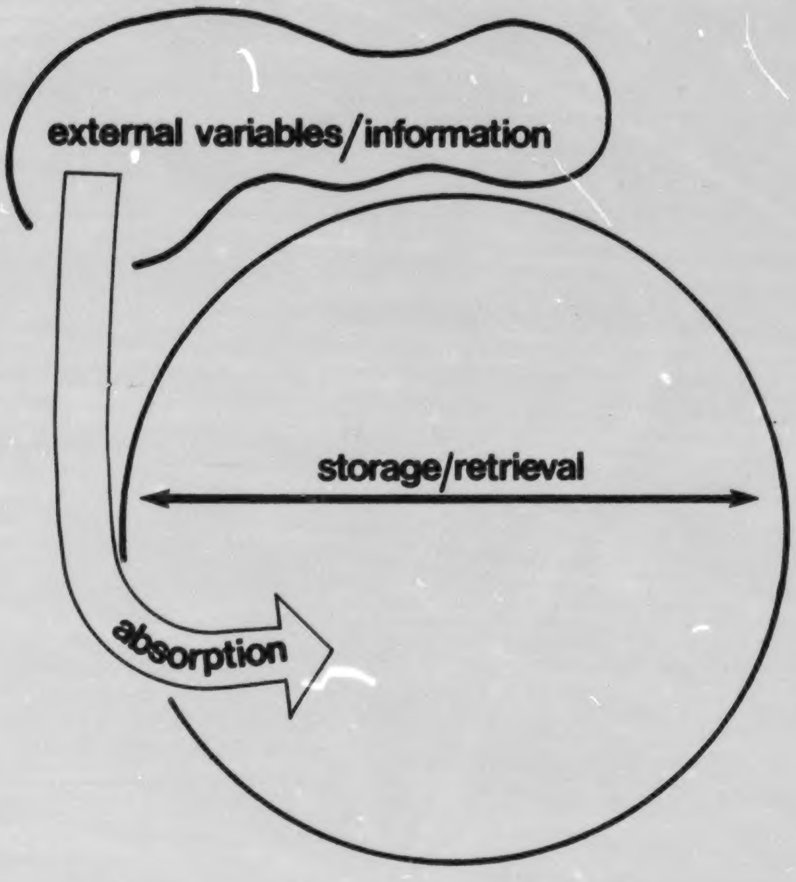

external variables/information
storage/retrieval
absorption

Figure 5 **The Preactive Learner**

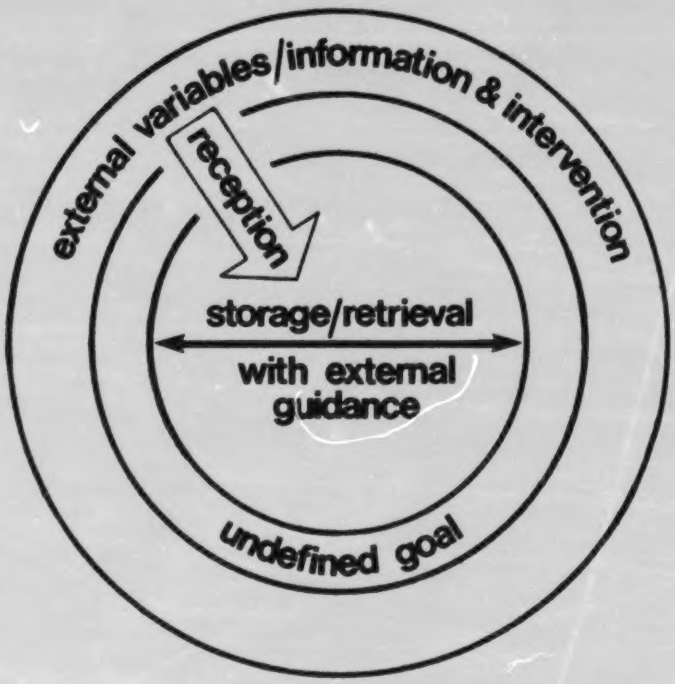

external variables/information & intervention
reception
storage/retrieval
with external guidance
undefined goal

Figure 4

Learners As Systems: Transitions

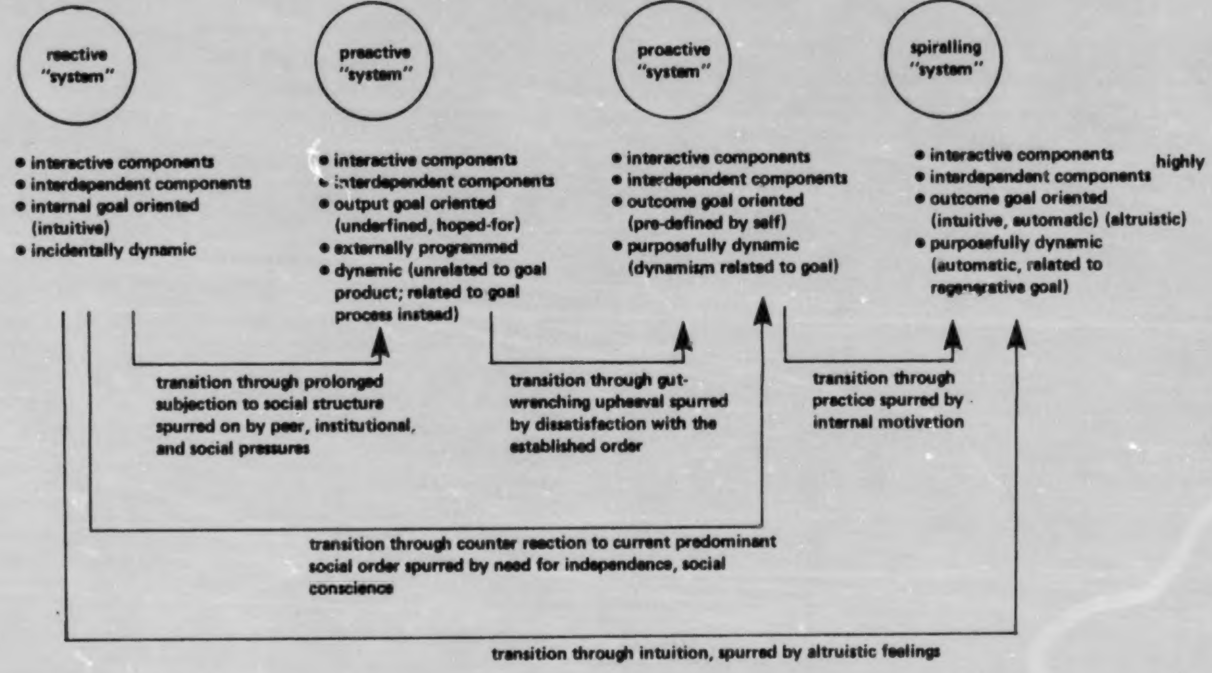
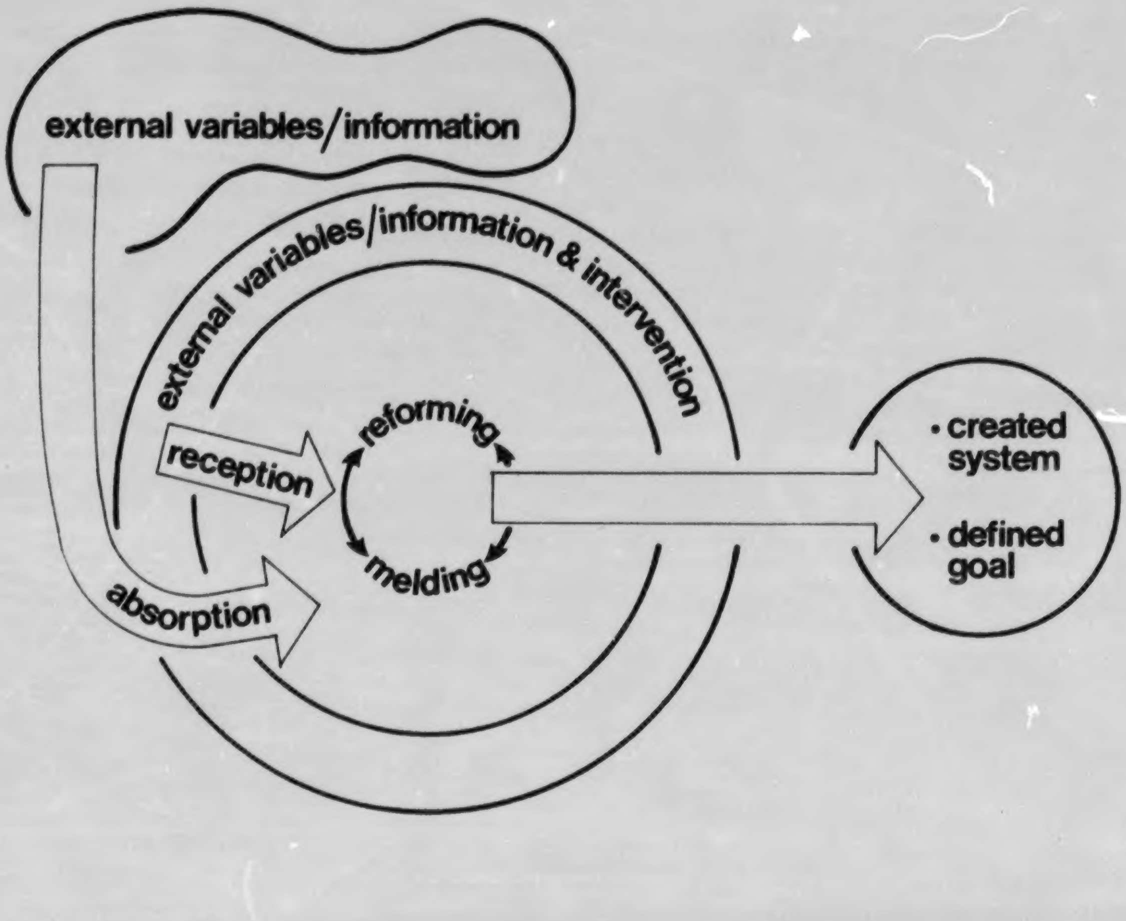

reactive "system"
preactive "system"
proactive "system"
spiralling "system"
• interactive components
• interdependent components
• internal goal oriented (intuitive)
• incidentally dynamic
• interactive components
• interdependent components
• output goal oriented (underfined, hoped-for)
• externally programmed
• dynamic (unrelated to goal product; related to goal process instead)
• interactive components
• interdependent components
• outcome goal oriented (pre-defined by self)
• purposefully dynamic (dynamism related to goal)
• interactive components
• interdependent components
highly
• outcome goal oriented (intuitive, automatic) (altruistic)
• purposefully dynamic (automatic, related to regenerative goal)
transition through prolonged subjection to social structure spurred on by peer, institutional, and social pressures
transition through gut-wrenching upheaval spurred by dissatisfaction with the established order
transition through practice spurred by internal motivation
transition through counter reaction to current predominant social order spurred by need for independence, social conscience
transition through intuition, spurred by altruistic feelings

Figure 6 **The Proactive Learner**



external variables/information
external variables/information & intervention
reception
absorption
reforming
melding
• created system
• defined goal

Figure 7 **The Spiralling Learner**

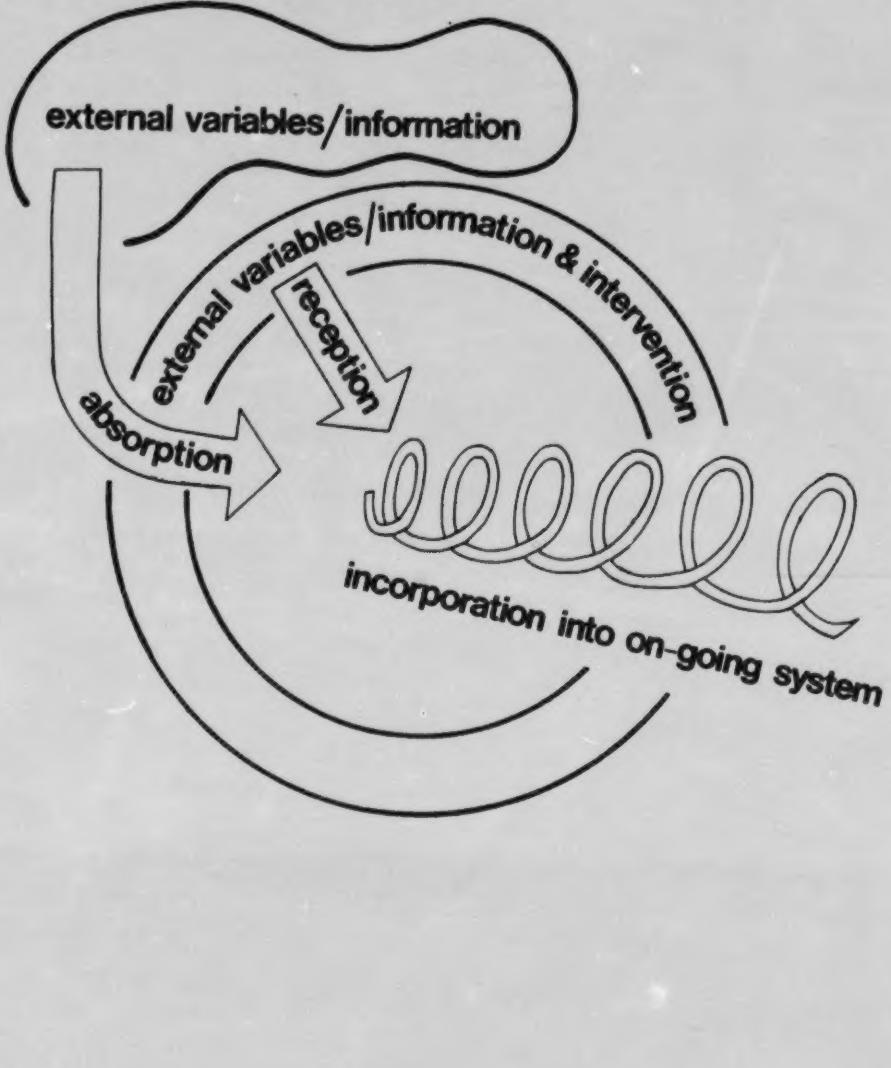

external variables/information
external variables/information & intervention
reception
absorption
incorporation into on-going system

Figure 8
Summary of Four Learner Systems

	Motivation	Response to External Variables	Response to Intervention	Predominant Strategies	Successful Learning Environment
Reactive	survival	absorbtion	rejection and/or absorbtion	reception	mentor
Preactive	social acceptance	acceptance	acceptance	accommodation	teacher-directed
Proactive	internal reinforcement	sifting and sorting	challenging resisting denying	introspection	traditional
Spiralling	altruism	applied absorbtion	systemic	dissonance	any

Figure 9
Transition Possibilities

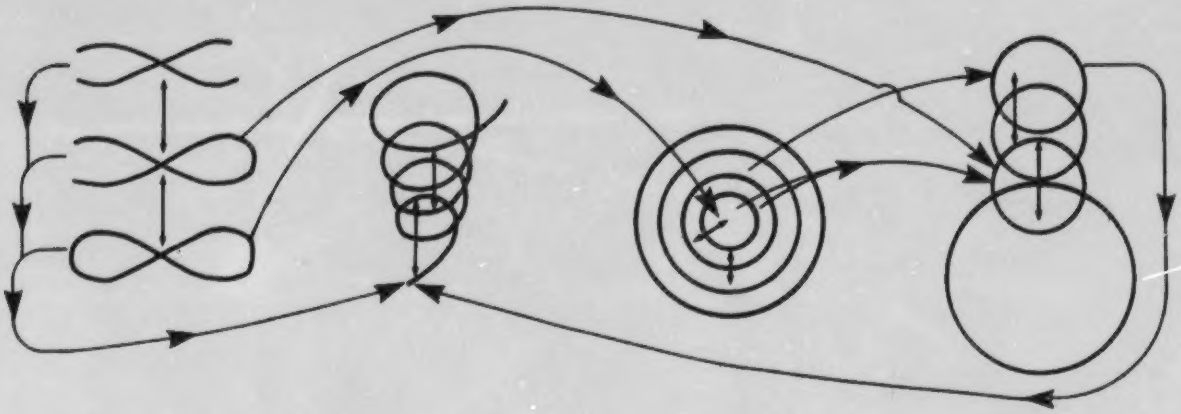
		unsophisticated						sophisticated					
		reactive			preactive			proactive			spiralling		
		l	m	h	l	m	h	l	m	h	l	m	h
reactive –	low		θ								+		
	middle	–		θ				+			+		
	high		–		θ						+		
preactive –	low			–		θ		+					
	middle				–		θ	+					
	high					–				+			
proactive –	low				–	–			+				
	middle							–		+			
	high								–		+		
spiralling –	low									–			
	middle										–	+	+
	high											–	

Figure 10
Learner System Reaction to Learning Environments

	Too Much Information	Too Little Information	Violation of Expectations
Reactive	▨	▨	Rejection
Preactive	More intense absorbtion	Anxiety	Frustration/ Anger
Proactive	Sifting/ Extracting	Addition from storage or other sources	Contingency Management
Spiralling	▨	▨	Exhilerating

Figure 11

Paradigm of Learner As Total System



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TITLE: The Effect of Cross Cultural Variations and
Color Realism on Pictorial Recognition Memory

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THE EFFECT OF CROSS CULTURAL VARIATIONS AND COLOR REALISM ON PICTORIAL RECOGNITION MEMORY

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ABSTRACT

The purpose of this investigation was two-fold: (1) to study the interaction between cross-cultural differences and pictorial recognition memory for pictures presented in three different color modes (realistic color, non-realistic color and monochrome); (2) to further confirm the value of signal detection analysis in the study of color recognition memory data.

Substantial research has investigated the role of color cueing in visual learning with frequently conflicting results. Virtually no research has explored how cultural differences relate to the processing of color cued information.

The methodology of signal detection theory has only recently been applied to such data analysis.

Subjects (74) of either Asian (35) or American (39) cultural origin participated in a recognition memory experiment employing three types of stimulus and distractor materials, realistic color, non-realistic color and monochrome.

The signal detection theory parameter, d', recognition rate and total error rate were analyzed by means of a two-way repeated measures design using analysis of variance procedures.

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Introduction

It has been suggested that various cultures differ in the way pictorial information is processed. Studies conducted in primitive African cultures (Hudson, 1967; Deregowski, 1971) have shown strong, culture based differences in pictorial depth perception and realism in terms of color vs. monochrome visuals. Little research attention, however, has focused on perceptual differences between "developed" cultures. The purpose of this study was to (1) identify perceptual differences between two developed cultures relative to the use of color as a visual cueing device, and (2) to further investigate the use of signal detection theory (SDT) analysis as a means of evaluating data from a visual recognition experiment.

Related Literature

In a summary of research, Deregowski (1972) concluded that " . . . there are persistent differences in the way pictorial information is interpreted by people of various cultures." The vast majority of these studies have, however, been conducted on primitive or developing cultures where strong environmental, as well as cultural factors control the perceptual and interpretive patterns of individuals. Hudson (1967) investigated the variable of depth perception among Bantu and other tribal groups in Africa. Berry (1966) compared African tribes and Eskimo tribes in terms of perceptual performance on the Embedded Figures Test. In a noteworthy review, Witkin and Berry (1975) summarized extensive research relating the perceptual variable of field dependence to cross-cultural variables.

Other studies conducted by Miller, 1973; Jahoda, Cheyne, Deregowski, Sinha & Collingbourne, 1976; Nicholson & Seddon, 1977 and Hagen & Jones, 1978, have addressed other perceptual variables as they differ across cultures.

Relatively little research has been denoted to the more subtle perceptual differences which may or may not exist between more developed cultural groups. One cultural difference which is often implied but has received little research attention is perceptual variations between western and easter cultures. One study (Opper, 1977) explored concept development across rural children within the Thai culture. A doctoral study (Sugg, 1980) compared eighth grade Thai and American children in their relative degree of ability to recognize abstract visuals. Little other research related directly to Asian/American perceptual differences has been located.

Substantial research has focused on the role of color in visualized instruction (Dwyer, 1972, 1978; Berry, 1974; Winn, 1976; Chute, 1979; Lamberski, 1980). This research represents one aspect of the larger theoretical debate which continues regarding visual complexity. It has long been contended that the mere addition of visual cues will increase the ability of the viewer to store and retrieve visual information. This orientation, termed "realism" by Dwyer (1967), has drawn strong theoretical support (Dale, 1946; Morris, 1946; Carpenter, 1953 and Gibson, 1954) and is indeed the major premise of cue summation theory (Severin, 1967). Other researchers (Broadbent, 1958, 1965; Travers, 1964) have, however, taken strong opposition to this "realism" orientation on the grounds that the human information processing system is of limited capacity and that, in times of rapid information reception, irrelevant cues may block the processing of other, relevant information. Studies (Kanner, 1968; Katzman and Nyenhuis, 1972; Dwyer, 1972 and 1979) have investigated this apparent contradiction with conflicting results.

The inclusion or absence of color information can be regarded as one dimension of visual complexity. Color can function in a dual role when used in visual displays. First, it can serve primarily a coding function, providing additional information but not providing any realistic description of the elements of the display. In this case, the effectiveness of color can be predicted by cue summation theory, but not by the realism hypothesis. Second, color can be cued to present a more realistic version of the visual display. In this instance, in addition to providing a greater number of overall cues, it provides the viewer with more realistic attributes or "handles" with which to store and retrieve information. When color is used in this cueing role, its value could be predicted by the realism theories as well as by cue summation theory.

Much past research investigating the differences between color and black and white visuals failed to take into account the fact that realistic color visuals contain intrinsically more information and consequently require more time for processing. In an attempt to resolve this methodological inconsistency as well as to more accurately assess the role of color in the storage and retrieval of visual information, Berry (1974) compared realistic and non-realistic color versions of the instructional materials on the human heart developed by Dwyer (1967). Data suggested that, in those learning tasks where visual materials contributed significantly to the improvement of instruction, realistic color materials were most effective. Later research (Berry, 1977, 1982) which investigated the color realism/coding question relative to pictorial recognition memory found both realistic and non-realistic color materials superior to black and white visuals. These findings suggested that cue summation theory may provide an accurate description of how color functions in basic information processing tasks such as picture recognition.

Simple comparison of recognition rates did not, however, take into account the subjects' rate of incorrect responses. It has been suggested by Swets, Tanner, and Birdsall (1964) that in recognition experiments, each observer applies a particular criterion value to each observation. Consequently it could be possible for a subject to identify all stimuli as having been seen previously, the result of which would be not only a high recognition rate, but also a high error rate. Similarly, if the observer were to apply a low criterion and reject all items as not previously seen, the resulting rate would be low with a correspondingly low error rate. It is apparent that analysis of pictorial recognition data should take into account the observer criterion and the resulting rate of error which accompany the recognition rate. The method of signal detection theory has been applied to the analysis of recognition data in the past as a means whereby both recognition rate and error rate are taken into account.

Signal detection theory has been accepted as a reliable technique for assessing a subject's ability to describe the occurrence of discrete binary events. The basic model of SDT was described in Swets (1961) and has been used extensively to study the ability of individuals to distinguish the presence of a signal when that signal was mixed with noise. More recently, Grasha (1970) has suggested the use of SDT parameters in the study of memory processes. Signal detection theory has been applied specifically to recognition memory experiments involving pictures in research conducted by Snodgrass, Volvovitz and Walfish (1972), Loftus and Kallman (1979), Loftus, Greene and Smith (1980) and Morrison, Haith and Kagan (1980).

In a typical recognition memory experiment, subjects are first presented with a series of stimulus items for study. These are subsequently presented for recognition in random combinations with new "distractor" items which have not been presented previously. When a stimulus item is presented, it can be said to represent signal plus noise (relevant and irrelevant cues) and when a distractor is presented, it represents noise alone (irrelevant cues). Based on statistical decision theory, four possible outcomes are possible (see Figure 1).

Figure 1

Types of Responses in a Yes-No Recognition Task

		Ss RESPONSE	
		Old (yes)	New (no)
ITEM	Stimulus S & N	"Hit" correct recognition	"Miss" (incorrect)
	Distractor N	"False Alarm" (incorrect)	Correct rejection

The first of these is a correct recognition, termed a "hit" (H) which represents the recognition data previously analyzed. The second possible outcome is the incorrect identification of a distractor item as a stimulus which is termed a "false alarm" (FA). The remaining two outcomes include a correct rejection of a distractor as "new" and an incorrect response to a stimulus, termed a "miss." The basic model of signal detection theory uses the probabilities of hits P (A), and false alarms P (FA), to calculate the parameter d'.

These probabilities are given by:

$$P\ (H) = \frac{w}{w + x} \quad \text{and} \quad P\ (FA) = \frac{y}{y + z}$$

where:

P (H) = the probability that S reports a stimulus when a stimulus item is present

P (FA) = the probability that S reports a stimulus when a distractor is present

w = number of hits
x = number of misses
y = number of false alarms
z = number of correct rejections

The measure of d' represents the difference between the means of the false alarm and hit distributions in relation to the standard deviation of the false alarm distribution (Marascuilo, 1970). In so doing, the factor of the subject's individual criterion of decision threshold is taken into account. The parameter d' is generally considered to be a valid and accurate measure of recognition memory strength.

The purpose of this investigation was two-fold: (1) to study the interaction between cross-cultural differences and pictorial recognition memory for pictures presented in three different color modes; realistic color, non-realistic color and monochrome (black and white); and, (2) to further confirm the efficacy of applying signal detection analysis to color recognition memory data as a means of obtaining a more accurate assessment of the role of color in visual information processing.

Method

The stimulus materials used in the study were the same as those used by Berry (1977) and Wieckowski (1980). These consisted of 150 stimulus slides and 90 distractor slides. All slides were obtained from a pool of travel and geographic scenery slides taken by several amateur photographers in various parts of the United States and Canada. In selection of the materials, care was exercised to exclude all recognizable human figures, verbal materials and unique objects. The entire collection of materials was randomly divided into approximate thirds. One third was retained as a realistic color group, a second third was recopied into black and white slides and the remaining third was altered by photographic reversal to produce a non-realistic color group. Through photographic reversal, the overall number of color cues could be held constant, while the degree of color realism could be manipulated.

The population for the study consisted of 74 university students, 35 of whom were of various Asian origins and spoke an Asian language as their native tongue. The remaining 39 were of American background and used English as their language.

The list learning procedure was employed, in which individual subjects were first shown the group of 150 stimulus slides, sequentially, for a short period of time (approximately 500ms). Subjects were then presented with a random distribution of all stimulus and distractor slides for fifteen seconds each. During that time, Ss responded verbally, either "old" (stimulus slide-seen before) or "new" (distractor slide-not seen before).

Results

The mean number of hits for each treatment and cultural group as well as the measure of sensitivity d' which was determined from tables developed by Elliot (1964) are presented in Table 1. In addition, total mean error rates for each treatment were calculated (total error rate = false alarm rate + miss rate) as suggested by Loftus, Green and Smith (1980) (see Table 1).

Table 1

Means and Standard Deviations for Number of Hits,
d' and Total Error Rate by Treatments Across Cultural Groups

		Realistic Color		Non-Realistic Color		Black and White	
		Mean	s.d.	Mean	s.d.	Mean	s.d.
ASIAN GROUP (N=35)	Hits	25.82	8.77	25.62	10.31	19.06	8.29
	d'	.190	.273	.377	.380	.248	.339
	Total Error	38.00	5.80	36.03	5.52	40.32	4.62
AMERICAN GROUP (N=39)	Hits	23.03	7.44	21.97	8.77	19.61	9.01
	d'	.128	.305	.262	.355	.201	.301
	Total Error	39.81	4.83	39.28	6.54	40.33	5.41

Analysis of variance procedures for repeated measures were conducted on the number of hits (recognition scores), d' and the total error scores. In all cases, significant F-values were obtained for the main effect of color. (Hit F = 12.33, p = 000; d'F = 4.32, p = .015; Total Error F = 5.12, p = .007).

The Tukey B procedure for pair-wise comparisons was performed to determine where significant differences existed. The results of these comparisons are summarized in Table 2.

Table 2

Summary of pair-wise comparisons for hit scores, d' and total error scores.

Hit Scores	d'	Total Error Scores
As RC > As BW	As NRC > Am RC	Am BW > As NRC
As NRC > As BW		As BW > As NRC
As RC > Am BW		Am RC > As NRC
As NRC > Am Bw		Am NRC > As NRC

As = Asian Group, Am = American Group.

Discussion and Conclusions

Findings relative to the cultural variable generally showed no significant difference across groups. The contention that different cultural groups may differ in this particular perceptual task was not supported. It is possible however, that the Asian groups, who are currently enrolled in an American university, have become acculturated to American society to the extent that their own cultural/perceptual styles have been altered and no longer reflect those of their own culture. It is obvious that replication of the study with Asian groups who have not left their culture, would help resolve this question. Generally, the Asian group performed better, although not to a significantly degree, than the American group.

In terms of the color variable, the analysis of hit (correct recognition scores) on the Asian group indicated the superiority of both color formats over the black and white format. This finding was, however, not confirmed by the analysis of the d' measure. Inspection of the total error scores shows a lower error rate for both color treatments in the Asian group and a high error rate for black and white. It would appear that Asian subjects tend to make fewer errors when materials are presented in color formats.

When the data obtained in this study are compared with findings reported by Berry (1982), certain differences exist. The superiority of realistic color found earlier, is not confirmed. Further examination of the hit and false alarm rates shows a much higher false alarm rate in this study than in the previous (Berry, 1982) research. Since all variables except the number of distractor slides was held constant, the difference must be attributable to this factor. Apparently, when the number of distractors is reduced, realistic color materials appear more familiar and a greater number of false alarms (identification of a distractor is a stimulus) occur. This point should be examined in further research.

Based on the findings, a number of conclusions can be drawn.

1. Black and white stimulus materials tend to produce greater error scores.

2. Color materials (realistic and non-realistic) tend, in some cases to produce higher recognition scores.

3. Cross cultural differences across Asian and American populations in terms of pictorial recognition do not seem to exist.

4. The variables of false alarm rates in relation to overall recognition should be studied further.

5. The method of signal detection theory can and should be applied to color recognition data analysis. In so doing, a more accurate assessment of the recognition and error rate interaction can be made.

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TITLE: Use of Fear in Persuasive Messages

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USE OF FEAR IN PERSUASIVE MESSAGES

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The light turned green and Cindy pulled her red 1963 Comet convertible into the intersection. She was returning from a night class and was tired. Something, no one will ever know what, made her look to her left. By then, however, the blue Continental Mark III sedan was only a few feet away.

Afterwards, Roger, the very intoxicated driver of the Continental who was hurrying home after a office party, said to police at the scene of the fatal accident that he didn't see the stop light that witnesses verified was red. "All I can remember is her face. She looked right at me. I couldn't do anything. I just hit her."

The camera then panned from a close-up of Roger's anguished face to a close-up of a blood-stained blanket covering Cindy's body. Her arm with a charm bracelet can be seen dangling from the stretcher, as the title "Death on the Highway--The Charm of Drinking," is superimposed over the scene.

BACKGROUND

In the 1950's and 60's many films with similar story lines were produced by public and private organizations. Intended to persuade viewers of the need for tougher drunk driving laws, the need to wear seatbelts, or the hazards of smoking, for example, they used fear as a key ingredient of the treatment for delivering their message. It was thought that by scaring viewers it would be likely that their attitudes would be changed to come in line with the socially preferable position advocated in the film, and that since attitudes are "pre-dispositions to respond", related behaviors would be influenced.

One disappointing consequence reported by viewers of these fear provoking films was that because some scenes were so unsettling and grotesque they were repelled from the entire persuasive message of the film. In other words, because some segments of these films were so fear-provoking and anxiety producing viewers were often likely to stop attending to them, and to ignore the general persuasive message of the film.

Fear Alleviation

Several researchers have proposed explanations to why the use of fear in films seemed to be an effective technique for changing attitudes in some instances, but not in others. Janis and Feshbach (1953) presented a slide/audiotape program on the effects of poor dental hygiene to high school students. They varied the intensity of a fear-arousing appeal in three versions of the presentation to determine the most influential delivery technique. All three methods were successful in producing aroused, affective reactions in the students. However, it was found that a minimal fear-arousing appeal was most successful in modifying attitudes because the stronger versions left students in a state of tension that was not alleviated by the remedies offered during the slide show. Janis and Feshbach concluded that strong, fear-producing appeals were not as effective in changing attitudes as were more moderate appeals because the audience became motivated to ignore the importance of the threat to reduce the tension they felt.

Rogers (1973) reported on a study that supported this position. Public health films dealing with cigarette smoking, safe driving, and venereal disease were tested in three different studies. It was found that the more noxious a film was the more fear that was aroused in viewers. However, it was also reported that these fear-arousing films were most effective in changing attitudes when preventatives or statements of probability of exposure to the malady discussed in the film were included as part of the motion picture.

The use of the correct dosages of fear coupled with the inclusion of remedies to the malady that produced the fear seem to be workable techniques to use when attitude change is desired. This study attempted to evaluate the effectiveness of fear and fear alleviation in a persuasive message as this technique was described by Simonson (1979) in Guideline #6 for designing instruction for attitudinal outcomes.

> "Guideline #6: Learners who experience a purposeful emotional involvement or arousal during instruction are likely to change their attitudes in the direction advocated in mediated message."

Purposeful emotional involvement could be thought of as the feeling produced in a viewer of a fear provoking message.

Attitude Defined

Attitude has been a difficult concept to adequately define, primarily because it has been defined by so many, but also because of its many lay uses and connotations. One of the earliest definitions of attitude was proposed by Thomas and Znaniecki (1918). They defined attitude as:

> A mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related (Thomas and Znaniecki, 1918).

In other words, while attitudes are latent and not directly observable in themselves, they do act to organize, or to provide direction to, actions and behaviors that are observable. Also, attitudes vary in direction, either positive or negative; in degree, the amount of positiveness or negativeness; and in intensity, the amount of commitment with which a position is held (Fleming and Levie, 1978).

Additionally, attitudes have three components: affective, cognitive, and behavioral (Zimbardo and Ebbeson, 1970). The affective component is said to consist of a person's evaluation of, liking of, or emotional response to some object or person. The cognitive component is conceptualized as a person's beliefs about, or factual knowledge of, the object or person. The behavioral component involves the person's overt behavior directed toward the object or person.

Specifically, the attitude construct evaluated in this study was "Attitude Toward Smoking," as measured by the Attitude Toward Smoking Test (Baer, 1966, r=.85).

PURPOSE

This study attempted to determine if a participant's attitude toward smoking could be altered by having them view an edited version of a film designed to persuade them that smoking was harmful. This film, The Feminine Mistake, used a number of scenes, such as an interview with a woman dying of lung cancer, designed to show the harmful consequences of smoking. In other words, the film attempted to provoke fear of smoking in the viewer.

Additionally, this film had a section showing techniques such as support groups and counseling, that could be used by the smoker to help him or her to stop. The two sections of the film were not specifically labeled, but were easily identifiable--fear first, alleviation next.

In order to determine if fearful scenes alone, or fear provoking scenes coupled with remedies, were differentially successful in changing attitudes, the motion picture was copied onto 3/4" videotape and edited into two versions of equal length. Version one had only introductory scenes and equal amounts of fear and fear-alleviating information. Version two, the fear treatment, was the same length as version one, but had only fear provoking scenes. All alleviation and remediation information was edited out. Both videotape versions were rated for technical quality and content by independent evaluators. They were rated high, and approximately equal.

Additionally, since previous research (Kloock, 1982) had shown that field dependence was related to attitude change, the Group Embedded Figures Test (GEFT; Witkin, 1971) was used to identify study participants who demonstrated a tendency to be field dependent or field independent so that any learning style interaction with the treatments could be uncovered. Other descriptive variables, such as sex, smoking habits, and parents' smoking habits, were identified and evaluated.

PROCEDURES

A post-test only, control group design was used (Campbell and Stanley, 1963). The study's 117 participants were college students. First, 150 students were given the Group Embedded Figures Test (GEFT) to identify their degree of field dependence. Only the most extreme field dependent, and most extreme field independent students participated in the study. Students at each of the two levels of field dependence were then randomly assigned to one of the treatment groups (control, fear only, fear and fear alleviation). Thus, six treatment cells were produced (2x3).

Students with GEFT scores near the mean of all scores were not included in treatments because they did not have a tendancy for being either field dependent or field independent. For this sample there was a slightly larger number of field independent than field dependent students so treatment cells were unequal.

Treatments were administered to participants in small groups of four or five. After the treatment, the test of the dependent variable, the Attitude Toward Smoking Test, was administered. Control participants only completed the test of the dependent variable. One hundred and seventeen student's scores were used to test hypotheses.

RESULTS

Four statistical tests were computed using the Smoking Attitude Test as dependent variable (see Tables 1-4). The first was a one-way analysis of variance that examined the differences in smoking attitude between the three treatment groups. The second test was a 2x3 analysis of variance that included an examination of the field dependence/field independence variable in addition to the test of the treatment factor. The third test was also a 2x3 analysis of variance. The two independent variables were treatment and gender. The last inferential test was a 3x3 analysis of variance. Subjects' smoking habits (smoker, former smoker, or non-smoker) were related to the experimental treatments. The perceived quality of the two experimental treatments were compared using a t-test. A reliability estimate of the dependent variable, the Smoking Attitude Test, was also computed.

Effect of Treatments on Smoking Attitude

Table 1 shows the results obtained when subjects were administered the Smoking Attitude Test after treatments wre viewed. Both the "fear provoking" persuasive treatment and the "fear with alleviation" persuasive treatment significantly influenced subjects' attitudes, as compared to subjects in the control group. In other words, subjects in the two experimental treatments had significantly more negative attitudes towards smoking than did control subjects who did not view a persuasive videotape. There was no significant difference between the Smoking Attitude Test scores reported by subjects in the two persuasive treatments.

Effect of Treatments on Smoking Attitude as Related to Field Dependence/Independence

Table 2 shows the results of the 2x3 analysis of variance test that used treatment and level of field dependence/independence as independent variables. The statistically significant differences between the two experimental treatments and the control group was identified again. However, there was no statistical difference found between the field dependent and field independent subjects in any of the three treatment groups. Additionally, there was no significant interaction identified. These results are contrary to the significant differences between field dependent and field independent subjects reported by Kloock (1982).

Effect of Treatments on Smoking Attitude as Related to Gender

Table 3 reports the results of the 2x3 analysis of variance test that used treatment and gender (male, female) as independent variables. The significant treatment effect was identified. However, the differences between men and women on the test of the dependent variable was not significant, and there was no significant interaction found. It was interesting that in all treatment groups the scores for men were more positive towards smoking than were the scores for women. Since the theme of the persuasive message was directed at women, this non-significant but actual difference between the sexes was worth noting. It also supports the somewhat obvious assumption of film-making that for a persuasive message to maximize its impact on the audience, its content should be aimed directly at that specific group.

Effect of Treatments on Smoking Attitude as Related to Smoking Behavior

Table 4 reports the results of a 3x3 analysis of variance test that used the three treatments and three categores of smoking behavior (smoker, former smoker, and non-smoker) as independent variables. Unexpectedly, the number of smokers and non-smokers who identified themselves was quite low, so drawing conclusions from the results of statistical tests was somewhat difficult. However, the information provided by the analysis of variance test indicated that in addition to the significant treatment effect, there was a significant effect related to a person's smoking behavior. Smokers in each treatment reported a more positive attitude toward smoking than did former smokers, and former smokers were more positive toward smoking regardless of treatment than were non-smokers. Because several cells had such small numbers of subjects, inferences drawn must be tentative. However, there did seem to be a direct relationship between behaviors related to smoking and attitude towards smoking. This relationship was expected.

Treatment Quality Comparison

After viewing the persuasive treatments subjects completed the Smoking Attitude Test. Included with this test of the dependent measure were several additional questions. One asked subjects to rate the technical quality of the videotape they viewed. Subjects in the "fear provoking" persuasive treatment had their scores to this question of technical quality compared to the scores of subjects in the "fear with alleviation" persuasive treatment. These scores were not significantly different.

Reliability Estimate for the Smoking Attitude Test

The Smoking Attitude Test was developed by Baer (1966). It was reported as having a reliability estimate of .85 (r=.85). This estimate was re-checked in this study using the Cronbach-Alpha method for determining a measure's internal consistency (Ferguson, 1971). Reliability was estimated at .82 (r=.82).

CONCLUSIONS

It seems fairly obvious that both treatments produced an actual, as well as statistically significant, attitude change, but that the amount of change did not seem to be directly related to a subject's level of field dependence or independence. There were, however, relationships identified between the amount of attitude change produced and a person's gender and smoking behavior. These results will be discussed below.

The general purpose of this study was to determine if a fear-laden persuasive message could be used to significantly alter attitudes towards smoking. Additionally, an attempt was made to determine why some individual's attitudes changed more, or less, than others.

One factor considered influential when attitude change was desired was a person's learning style. Specifically, the learning style called field dependence was thought to possibly be related to the impact of persuasive messages delivered by motion media. It was hypothesized that if a person demonstrated a tendancy to be either field dependent or field independent their attitudes might be differentially influenced. Kloock (1982) reported that field independent subjects who viewed a motion picture that was intended to change their attitudes were influenced significantly more than field dependent subjects who viewed the same film.

Other factors considered important for careful examinaion in this study were gender and smoking behavior. Since the treatment chosen for this study was a persuasive film designed to convince women that smoking was harmful, and that they should not smoke, it was hypothesized that women would be influenced by this motion picture to a greater extent than men. It was also assumed that a person's smoking behavior would influence how much their attitudes would be changed. The results of this study tend to support these suppositions. There was no measure of smoking behavior change, or post treatment follow up check on the persistence of attitude changes.

Persuasiveness of Fear Provoking Messages

The motion picture, THE FEMININE MISTAKE, used a number of scenes that graphically demonstrated the harmful consequences of smoking. The film also had scenes that gave remedial steps a smoker could take to reduce dependence on cigarettes. The obvious purpose of this motion picture was to persuade people, primarily women, that smoking was harmful to them. Two experimental treatments were produced from this film. One included nearly all the scenes that described the hazards of smoking. It was called the "fear provoking" treatment. The second treatment contained the most vivid of the fear scenes, but also added an approximately equal amount of information that showed how the viewer could stop smoking. This segment was called the "fear with alleviation" treatment. Both videotapes were approximately equal in length, and both were judged by viewers to be of equal technical quality.

The results of the first analysis of variance test showed that both treatments produced significant attitude changes in subjects who viewed them, when compared to control subjects. Thus, Simonson's Guideline #6 for designing instruction for attitudinal outcomes was supported. (This guideline states that viewers of persuasive messages who experience a purposeful, emotional involvement, such as fear, while watching a presentation will be likely to have their attitudes changed in the direction advocated; Simonson, 1979).

However, the proposal made by Janis and Feshbach (1963), and supported by Rogers (1973), that fear provoking messages would be mose successful if they aroused a minimum amount of apprehension and provided an alleviation to this fear, was not supported by the data collected in this experiment. The attitude towards smoking scores of subjects in the "fear provoking" was not significantly different from the average attitude score for subjects in the "fear with alleviation" treatment.

Relationship Between Persuasive Messages and Field Dependence

In 1982, Kloock reported that students who had a tendancy towards being field independent were more likely to have their attitudes influenced by a persuasive motion picture than were field dependent students. The results of the 2x3 analysis of variance reported in Table 2 did not support Kloock's finding. There was no significant difference in scores for the SAT for field dependent or field independent students. This inconsistency requires additional testing and evaluation in subsequent studies.

Relationship Between Persuasive Messages and Gender

The primary target audience for the film, THE FEMININE MISTAKE, that was used as the basis for the persuasive treatments for this study, was young women. Attitude change literature (Insko, 1969; Simonson, 1979) has proposed the idea that persuasive messages would be more effective if they were produced to be as realistic and relevant to the target audience as possible. In other words, a motion picture aimed at female smokers would be hypothesized as having its greatest impact on women. The data reported in Table 3 supported this hypothesis. Because there were very few men in the sample, conclusions related to gender must be tentative. However, it does seem that women were influenced to a greater degree than men by the treatments.

Relationship Between Persuasive Messages and Behaviors

A relatively small number of smokers or former smokers participated in this study, so conclusions were difficult to propose. However, there did seem to be a relationship between smoking behavior and attitude towards smoking. As might be expected, smokers were the most positive towards smoking, former smokers were next, and non-smokers were the most negative. Treatment effects were difficult to determine because of the small numbers of subjects in several treatment cells.

IMPLICATIONS AND RECOMMENDATIONS

The impact of mediated instruction on attitude formation and change has been examined and reported in an insufficient number of studies in the literature, so few broad generalizations about the relationship between these two concepts can be made. However, the results of this study do seem to support the assumption that persuasive messages can be effectively delivered with instructional media. What is not understood is why some learners are influenced more or less than others. In an attempt to answer this question this study examined subjects' level of field dependence to determine if this relatively constant learner characteristic was related in any way to attitude change. In this study it was not. Certainly, other learner characteristics than field dependence need to be examined in experimental situations to determine if they are related to attitude change. Also, the inconsistent results for field independent learners reported by this study as compared to the Kloock (1982) study needs further investigation. Other relevant learning styles should be examined in similar experimental situations so that the impact of mediated persuasive messages can be more accurately predicted.

It seems obvious that it is possible to change attitudes with media. A number of studies reported on above support this generalization. It may even be that persuasion is one of the most important contributions of media to education. Further experimentation is needed.

TABLE 1: ANALYSIS OF VARIANCE FOR ATTITUDE CHANGE BY TREATMENTS

A. DESCRIPTIVE STATISTICS

	Treatments			
	Fear Provoking Videotape	Fear With Alleviation Videotape	Control	Totals
Mean	39.46*	40.70	48.00	42.57
Standard Deviation	9.55	10.24	11.00	10.83
Number	35	46	36	117

*Higher scores indicate a more positive attitude toward smoking.

B. ANALYSIS OF VARIANCE

Source	D.F.	SS	MS	F	P
Between	2	1562.21	781.10	7.39	.001*
Within	114	12052.39	105.72		
Total	116	13614.59			

*p.< .05; Duncan's Test showed that the control group scored significantly more positive toward smoking than did either experimental group. Experimental groups were not significantly different.

TABLE 2: ANALYSIS OF VARIANCE FOR ATTITUDE CHANGE FOR TREATMENT AND FIELD DEPENDENCE/INDEPENDENCE

A. DESCRIPTIVE STATISTICS

		Treatments		
		Fear Provoking Videotape	Fear With Alleviation Videotape	Control
Field	$\overline{X}$	38.93	41.23	47.50
Dependent	SD	7.78	11.67	6.76
Group	N	15	22	14
Field	$\overline{X}$	39.85	40.21	48.32
Independent	SD	10.87	8.95	13.16
Group	N	20	24	22

B. MULTIPLE ANALYSIS OF VARIANCE-TREATMENT BY LEVEL

Source	DF	SS	MS	F	P
Main Effects	3	1562.56	520.85	4.81	.003*
Treatment	2	1554.52	777.26	7.17	.001*
Level	1	0.35	0.35	.00	.96
Interaction	2	24.50	12.25	.113	.89
Explained	5	1587.06	317.41	2.93	.02
Residual	111	12027.41			
Total	116	13614.47			

*Significant result

TABLE 3: MULTIPLE ANALYSIS OF VARIANCE FOR ATTITUDE CHANGE FOR TREATMENT AND SEX

A. DESCRIPTIVE STATISTICS

		Treatments			
		Fear Provoking Videotape	Fear With Alleviation Videotape	Control	Total
	$\overline{X}$	46.80	40.87	54.00	45.13
Males	SD				
	N	2	15	7	24
	$\overline{X}$	39.09	40.61	46.55	41.96
Females	SD				
	N	32	31	29	92
	$\overline{X}$	39.50	40.70	48.00	
Totals	SD				
	N	34	46	36	

B. MULTIPLE ANALYSIS OF VARIANCE

Source	DF	SS	MS	F	P
Main Effects	3	1731.27	577.09	5.45	.002*
Treatment	2	1540.18	770.09	7.27	.001*
Sex	1	187.96	187.96	1.78	.185
Interactions	2	215.30	107.65	1.02	.365
Explained	5	1946.57	389.31	3.68	.004
Residual	110	11646.81	105.88		
Total	115	13593.38	118.20		

*Significant result

TABLE 4: MULTIPLE ANALYSIS OF VARIANCE FOR TREATMENTS AND SMOKING HABITS

A. DESCRIPTIVE STATISTICS

		Treatments			
		Fear Provoking Videotape	Fear With Alleviation Videotape	Control	Totals
Smokers	$\overline{X}$	56.00	52.33	67.25	60.25
	SD	-	15.26	11.50	
	N	1	3	4	8
Former Smokers	$\overline{X}$	46.50	45.00	47.80	47.13
	SD	.71	-	9.81	
	N	2	1	5	8
Non-Smokers	$\overline{X}$	38.50	39.76	45.19	40.81
	SD	9.33	9.61	8.21	
	N	32	42	27	101
Totals	$\overline{X}$	39.46	40.70	48.00	42.57
	SD				10.83
	N	35	46	36	117

B. MULTIPLE ANALYSIS OF VARIANCE

Source	DF	SS	MS	F	P
Main Effects	4	3933.48	983.37	11.19	0.001*
Treatment	2	954.65	477.33	5.43	0.006*
Smoking Habits	2	2371.28	1185.64	13.49	0.001*
Interactions	4	188.74	47.19	.537	0.71
Explained	8	4122.22	515.28	5.86	0.001*
Residual	108	9492.25	87.89		
Total	116	13614.47	117.37		

*Scheffe tests indicate that smoker's control group is significantly different than the non-smokers who saw the fear videotape and the non-smokers who saw the fear with alleviation videotape.

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TITLE: The Relationship of Background and Demographic
Variables to the Perceived Performance and
Importance of Selected Functions of School
Media Specialists

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THE RELATIONSHIP OF BACKGROUND AND DEMOGRAPHIC VARIABLES TO THE PERCEIVED PERFORMANCE AND IMPORTANCE OF SELECTED FUNCTIONS OF SCHOOL MEDIA SPECIALISTS

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THE RELATIONSHIP OF BACKGROUND AND DEMOGRAPHIC VARIABLES TO THE PERCEIVED PERFORMANCE AND IMPORTANCE OF SELECTED FUNCTIONS OF SCHOOL MEDIA SPECIALISTS

The problem of this study was to provide information concerning the relationship between the functions of school media specialists and the background and demographic variables associated with media professionals who work in school media centers. The perceived involvement of subjects in six functions and the perceived importance of the functions were related to five background and demographic variables pertaining to the subjects who were employed in secondary schools. It was felt that such a study could begin to profile media professionals at the school level, and that such a profile could be used as a base on which to reevaluate and improve the preparation of school media personnel. The construction of such a profile also suggested its potential as a tool for matching perceptions of media specialists with characterists of school centers in future assignments of job responsibilities.

METHOD

Five of the six job functions used in the study were chosen from the Behavioral Requirements Analysis Checklist (School Library Manpower Project, 1973). Permission for this use was obtained from the American Library Association. The five functions chosen were: Human Behavior, Instructional Development, Planning and Evaluation, Research, and Professionalism. A sixth function, External Cooperation, was selected and defined from suggestions in the literature and from the experiences of this investigator.

The one hundred and fifty-six secondary school media specialists who took part in the study were employed full-time in public schools in Iowa. The subjects were stratified according to the following five variables:

1. The number of quantified standards(guidelines) met by the center in which the media specialist was employed.
2. The size of the school district(enrollment) in which the media specialist was employed.
3. Location(Area Education Agency region) of the school in which the media specialist worked.
4. Professional endorsement held by the media specialist.
5. The number of years the media specialist had worked in his or her present building assignment.

Data Collection Instrument

Data for the study were collected through the use of a two-part questionnaire. Part I of the questionnaire asked the respondent to indicate the type of professional endorsement she or he held, and the number of years she or he had been working in his or her present building assignment.

Part II of the questionnaire contained 82 task statements grouped under the six functions. Each statement was assigned five options for frequency of task performance (0=never to 4=always) and five options for importance of task performance (0=minor importance to 4=major importance). Respondents were asked to choose an option on each of the two scales for each statement.

Data Analyses

Pearson product-moment correlation coefficients were produced in two matrices. The first matrix (Table 1) shows coefficients which were obtained when the six frequency subscales were correlated with four of the five classifications of media specialists. Table 2 depicts coefficients that were obtained when the six importance subscales were correlated with the same four classifications. Coefficients reaching .16 were significant at the .05 level. Those reaching .21 were significant at 01. One-way analysis of variance was used to test for differences between location subgroups(AEA regions). This procedure was used because location, as defined in this study, was not a continuous variable, and therefore, was inappropriate for use in correlation analysis. This analysis is reported in Table 3.

RESULTS

Examination of Table 1 revealed no correlation between number of media center standards and any of the six frequency subscales. Table 2 also showed no relationship between number of standards and perceived importance of center tasks.

When frequency subscale ratings were correlated with district size groups (Table 1), there were significant correlations between these two variables. Instructional development and planning and evaluation correlated significantly at .01 level. Size of school district also showed a significant (.05) positive relationship with research (.188) and professionalism (.177). These coefficients suggested that in larger school districts, with more resources and more adequate staff, media specialists are able to engage in professional activities more frequently. These findings are also congruent with those of Turner and Martin (1978) and Burnell (1979). These writers have suggested that media specialists in large or urban areas received more support from their principals, and enjoyed a high level of professional autonomy in conducting their media programs.

On the importance subscales, size of school district correlated significantly (.05) with planning and evaluation (Table 2).

TABLE 1.. Correlation coefficients for classification groups and frequency subscales

	Human behavior	Instr. dev.	Plan. and eval.	Research	Prof.	External coop.
Number of guidelines	-0.0173	0.0911	0.0843	0.0285	0.0325	0.0623
District size	0.1555	0.2125**	0.2271**	0.1884*	0.1773*	-0.0424
Endorsement	0.1416	0.1933*	0.2135**	0.1053	0.1729*	0.0899
Years in present employment	0.1602*	0.1653*	0.1142	0.1039	0.0897	-0.0893

*Significant at .05.

**Significant at .01.

TABLE 2. Correlation coefficients for classification subgroups and importance subscales

	Human behavior	Instr. dev.	Plan. and eval.	Research	Prof.	External coop.
Number of guidelines	0.0108	0.0260	-0.0253	-0.0216	0.0195	-0.0950
District size	0.0618	0.0876	0.1742*	0.0520	0.0385	-0.1274
Endorsement	0.1567	0.1867*	0.2219**	0.0315	0.0488	-0.0070
Years in present employment	0.1168	0.0760	0.0377	0.1098	0.0109	-0.1378

*Significant at .05.

**Significant at .01.

TABLE 3. Results of one-way analysis of variance for frequency and importance subscales for AEA regions (n = 156)

Subscales	F ratio	F probability
Frequency subscales		
Human behavior	1.791	.065
Instructional development	1.003	.453
Planning and evaluation	.448	.955
Research	.747	.724
Professionalism	.905	.555
External cooperation	1.652	.072
Importance subscales		
Human behavior	.314	.991
Instructional development	.991	.465
Planning and evaluation	.821	.644
Research	1.513	.113
Professionalism	.711	.760
External cooperation	1.540	.104

Correlations between endorsement(training) of subjects and ratings on the twelve subscales produced five coefficients which were significantly different from zero. There were positive relationships between endorsement and instructional development, planning and evaluation, and professionalism on the frequency subscales. Significant correlations on the importance subscales were obtained with instructional development and planning and evaluation. These findings suggested that media specialists who were trained in audiovisual technology were more involved in these functions and considered them more important than did media specialists with training primarily in library science.

There were positive correlations between years of service in present assignment and human behavior (.160*) and instructional development (.165*) on the frequency subscales. It would appear that time is necessary to cultivate the kind of relationships with teachers which would facilitate exchange in the instructional development process.

The analysis of variance technique (Table 3) failed to detect any significant differences in the perceptions of media specialists when stratified by location (AEA regions). It was possible that regional media center boundaries cut across many varying characteristics of schools and school personnel, making it difficult to detect differences between such regions.

CONCLUSIONS

1. There was no detectable relationship between the extent of development(number of standards met) of the media center and the functions of the media specialist.

2. The size of the school district in which the media specialist

worked appeared to influence the performance of the media specialist in instructional development, planning and evaluation, research, and professionalism.

3. There was a relationship between the level and type of training of the media specialist and his or her involvement in instructional development, planning and evaluation, and professionalism. Those trained in audiovisual technology were more involved in these functions than were their colleagues who were trained primarily in library science.

4. Length of service in building assignment was related to performance in human behavior and instructional development tasks.

5. Perceptions of subjects were not influenced by the location (AEA region) of the school in which the subject was employed.

SUGGESTIONS FOR FURTHER RESEARCH

1. There should be further comparisons of media professionals with different levels and types of certification. Such a study could include variables pertaining to personality, school-wide responsibilities which are not directly related to the media program, and other aspects of the school setting which were not included in the present study.

2. A model should be developed and tested which could be used to facilitate building-level and regional-level media program cooperation.

3. Research should be conducted to provide information concerning the assimilation of the new school media specialist into the instructional development process.

4. The study should be replicated at the elementary school level.

Recommendations

At a time when schools are confronted with the possibility of a sharp reduction in program services, it becomes vital that leaders in the library media field work to insure the survival of media programs in the schools. Findings from this study could aid in developing ways to safeguard that survival. Among these are:

1. Results of the study could be used as a basis for reevaluating the curricula in schools which train school media personnel. Areas in which respondents were less involved could form the nucleus around which evaluative criteria could emerge. This appears particularly important in schools which offer library science degrees.

2. Educators in schools of library science could use the findings as criteria for recruiting more students with undergraduate degrees in education to prepare for school media service. Generally, library schools have recruited most students from liberal arts backgrounds (Hannigan, 1980).

3. Directors and other professional personnel in regional media centers could use these findings to conduct in-service workshops, seminars, or formal courses in their regions. Areas of activities in which respondents showed the least involvement could form the theme of the in-service training.

4. Cooperation between media programs should be encouraged. Directors of regional media centers could make use of the results of this study to seek new ways to support and interact with building level programs. This is vitally important in regions with very small schools.

5. Superintendents and school principals could use the findings as as basis for assignment of media specialists to schools where certain needs have been demonstrated.

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APPENDIX

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FIGURE 1

Frequency and Importance Means for Entire Population
(n=156)

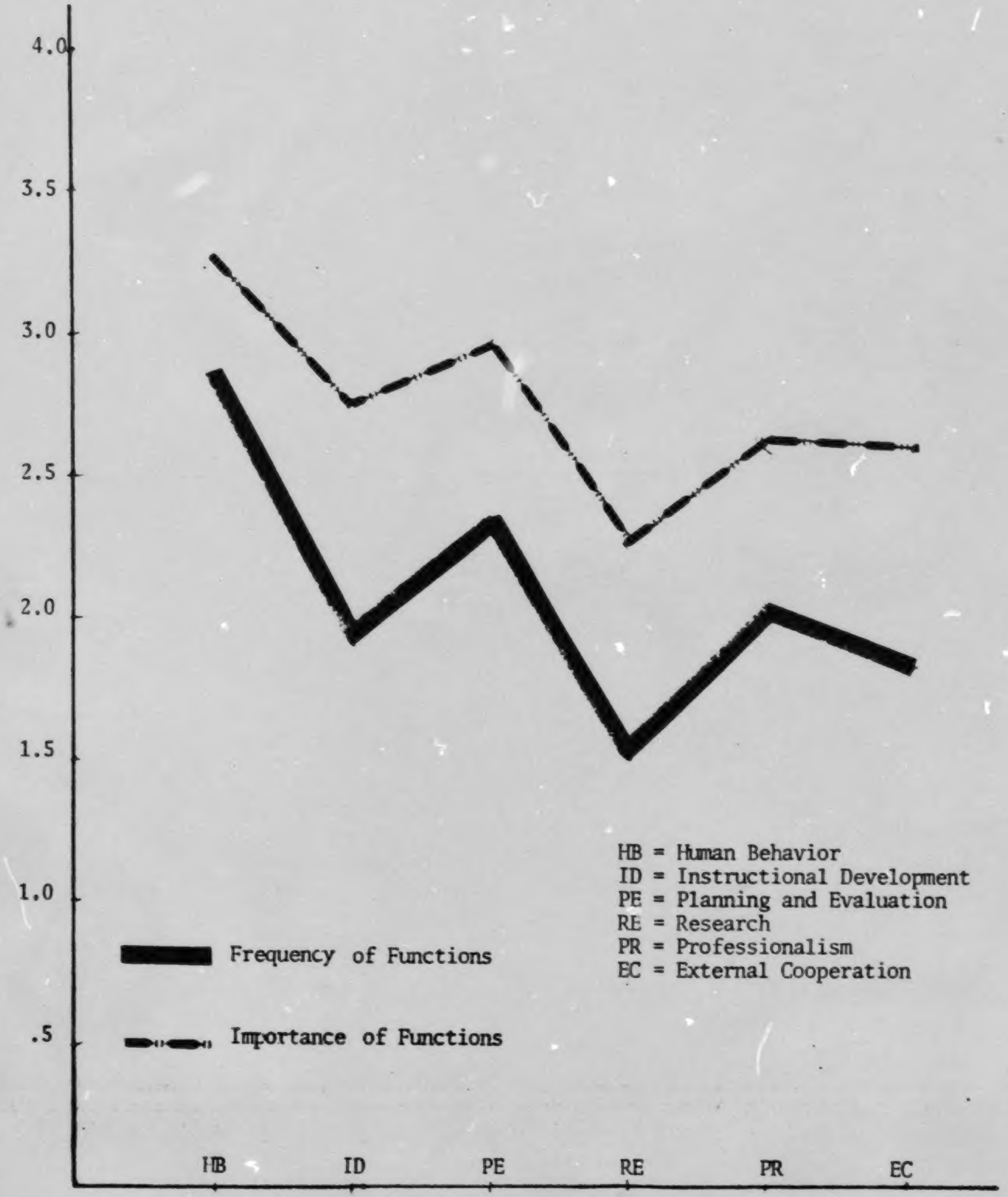


FIGURE 2

Frequency Means of Three Endorsement Groups

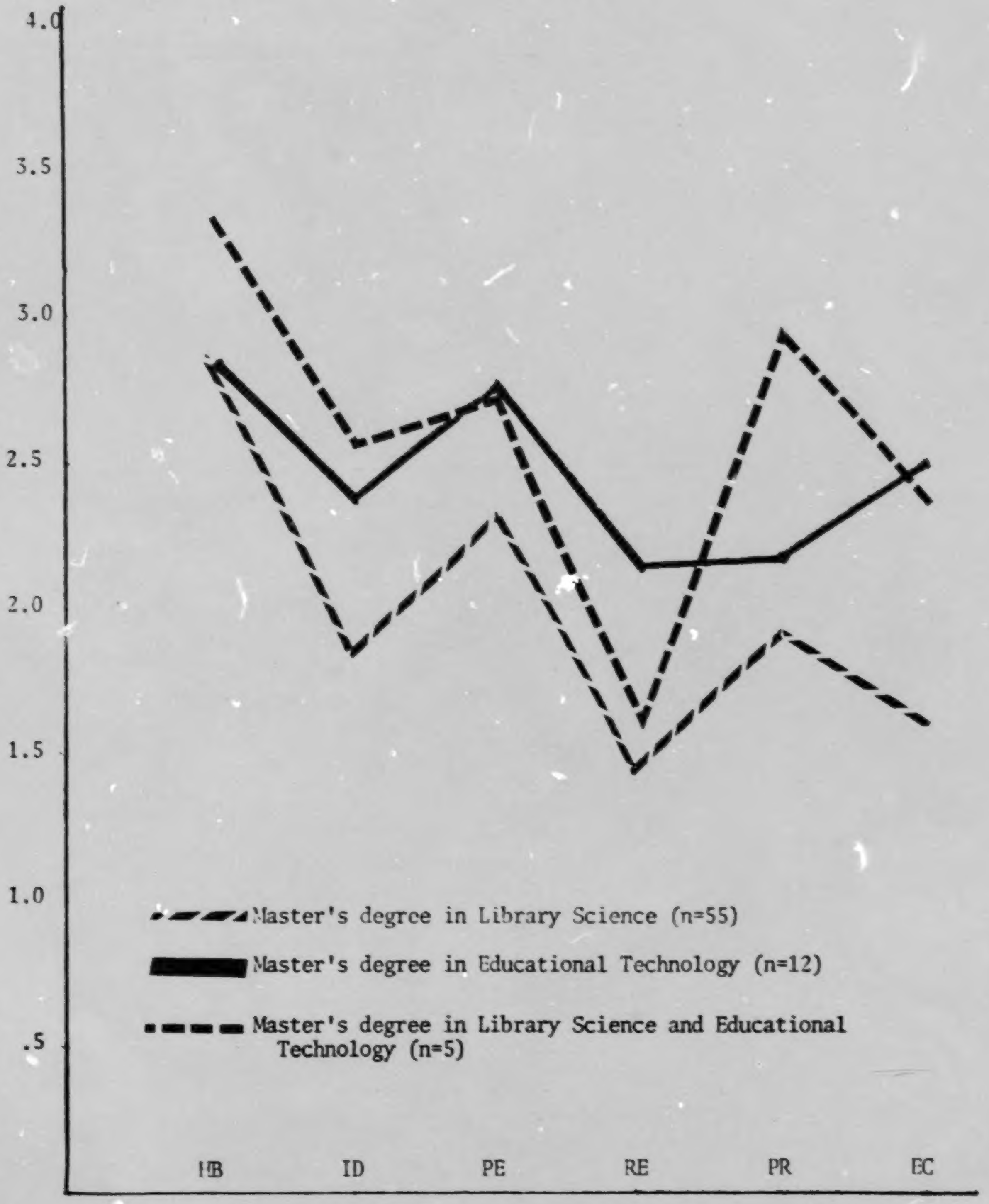
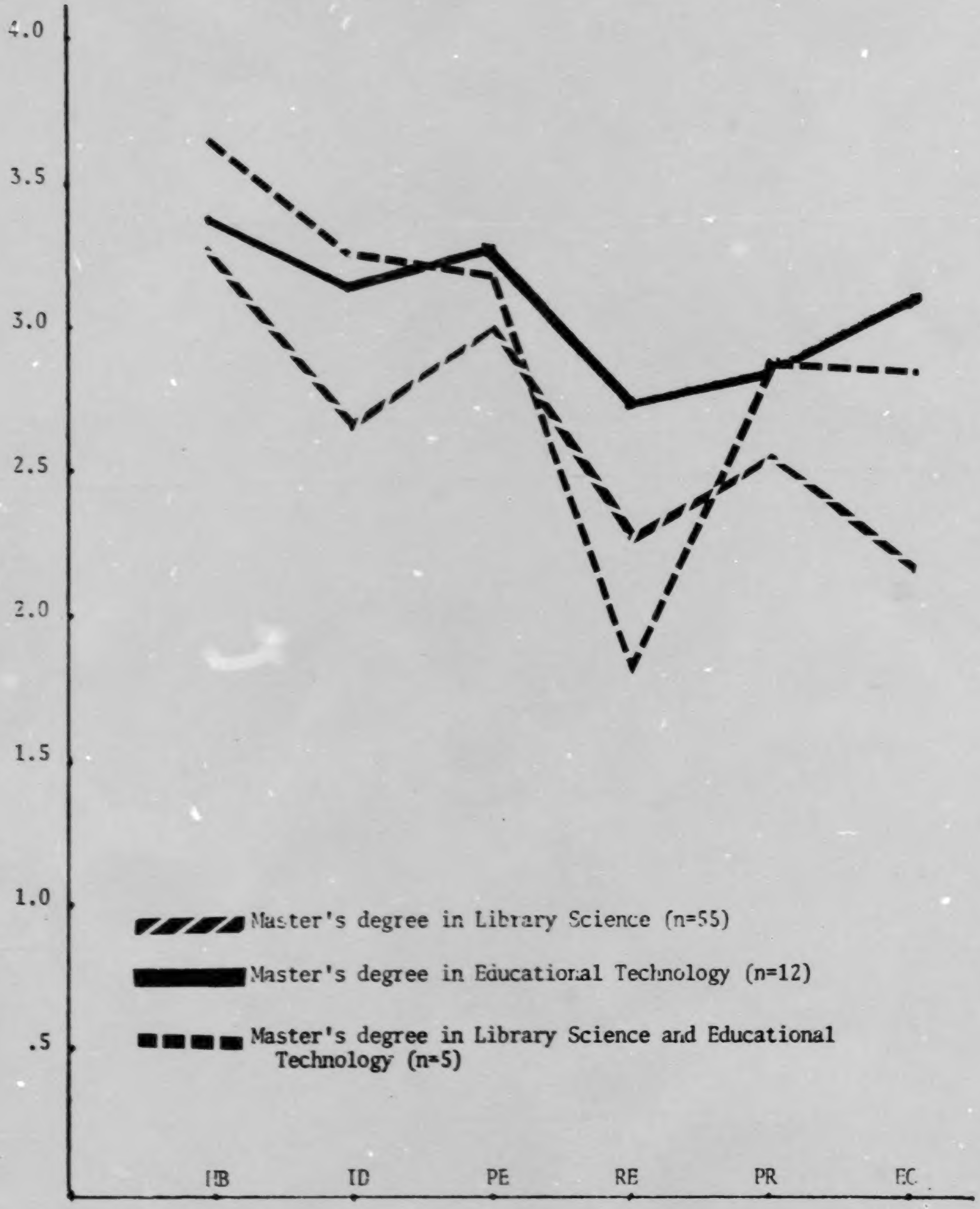


FIGURE 3

Importance Means of Three Endorsement Groups



TITLE: A Function-Based Approach to Pictorial Research

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A Function-Based Approach to Pictorial Research

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Abstract

In spite of considerable research on various aspects of pictures and their instructional uses, a clear conspetion of the instructional potential of pictures is missing. As a result, practioners who deal directly with the instructional process are limited in their ability to use pictures most effectively and efficiently. The approach to picture research being described attempts to make research more relevant by suggesting the need to pay greater attention to the instructional role or function served by pictures. Potential functions must be described in terms of their contribution to instructional processes and procedures. Functions should also be applicable to a wide variety of objectives, strategies, and procedures. The ability of this approach to be relevant to both basic and applied pictorial research is also discussed.

A Function-Based Approach to Pictorial Research

Instructional technologists have long been disappointed and disillusioned with the results of research into the instructional uses of pictures. Despite numerous studies over the last forty years, an uneasy feeling remains regarding the ability of research on the instructional uses of picture to provide the information necessary for finding solutions to common instructional problems. It appears that pictorial research has often failed to provide teachers and instructional design specialists with useful information about the instructional characteristics of pictures. Although the gap between research and practice is common to many disciplines, it is particularly significant to research into the instructional uses of pictures where the intuitive appeal of pictures has not always been supported by the results of empirical inquiry.

As suggested by Snow (1974) and Salomon and Clark (1977), the utility of pictorial research can be increased through methodological decisions. However, such an approach is only a partial solution to the problem, for methodology cannot take the place of the formulation and examination of appropriate research questions and issues. This paper speaks to the latter issue, that of developing a research approach which will assist in producing results that are meaningful to the scholar and researcher, while at the same time are relevant to the practitioner.

Background

A brief examination of relevant research conducted over the last forty years reveals a variety of approaches, each emphasizing a different way of looking at the instructional potential of pictures. While these approaches fulfilled the need to establish a tradition of research for the study of pictures, they were also laden with their own particular, and narrow, viewpoint; a broader, more useful conception of pictures was largely ignored.

Providing limited utility at best, research based on gross media comparisons, which neglects to examine the elements that make up a picture, could only conclude that pictures, under certain conditions, could affect learning. In contrast, research grounded in the realism continuum often concentrated on pictorial attributes such as color and fidelity, without paying a great deal of attention to the overall role to be served by the picture. In spite of the intrinsic appeal of the realism continuum, studies have generally failed to support the existence of a firm relationship between the degree of realism and the amount of learning in any reliable, systematic manner (Travers, 1967; Dwyer, 1978).

Research based on the aptitude-treatment interaction paradigm, while admirable for its attention to learner characteristics, has also failed to contribute greatly to advancing the understanding of the instructional role of pictures. In addition to some general limitations regarding the ultimate utility of this approach for solving classroom problems (Merrill, 1975), ATI research has either ignored pictures as a treatment variable or has placed pictures in a noncritical, secondary role. In short, ATI research has too often conducted research with pictures, rather than research on pictures.

The need to examine the effects of selected media attributes on internal cogitive processes has been emphasized by many over the last several years (Salomon, 1972, 1979; Gardner, Howard, & Perkins, 1974;

Levie, 1978). While a substantial amount of empirical evidence has been found to support the contention that media can affect the way information is processed, the overall importance of this approach to picture research may lie in the fact that it is concerned with outcomes other than those related to the transfer of information and that it pays attention not only to selected attributes, but to the instructional role served by these attributes. In spite of the current appeal, and potential utility, of symbol system-cognitive process interactions, such an approach draws considerable attention away from the concerns of practitioners who are more often concerned with prescriptions of what works rather than descriptions of how something works. Once again, the balance between basic research and applied research is missing.

Limitations notwithstanding, some useful information has been generated by picture-based research over the years; however, the conclusions produced by the disparate research are not quite satisfactory, for they have failed to identify a clear conception of the instructional role of pictures. Conclusions such as the utility of cueing devices; the tendency for pictures to be remembered better than words; the relationship between picture types and different learning objectives; and even the effect of pictures on cognitive processes have not led to a coherent strategy for effectively utilizing the instructional potential of pictures. Without such a unifying strategy the cares and concerns of the teacher and the instructional designer will continue to be ignored. This is not to denegrate or minimize the need for basic research. Rather, it is an appeal to instructional technologists to develop a research strategy whose purpose is to generate knowledge that will help practitioners effectively use pictures to solve a variety of instructional problems. Appealing to instructional technologists to develop such an approach is appropriate and natural, for it is only in the domain of instructional technology that the effects of media on instruction is of central concern. While research in areas as diverse as perception, cognition, and mass communications, incorporate pictures into their research designs, their primary interests lie in directions other than instruction. Thus, if increasing the instructional potential of pictures is indeed valuable, instructional technologists must assume the responsibility for developing a suitable approach which does not lose sight of its obligations towards the development of a science of instruction.

Such an approach will need to expand the traditional preoccupation with color, realism, and other physical/perceptual elements to include additional components of the instructional picture such as content and function. While most would agree that a picture is used for a specific purpose or function by representing events and/or objects (content) through the organization of pictorial elements such as color, line and space (physical elements), pictorial research has continued to emphasize the physical components of pictures at the expense of content or functional components. Of the two neglected components--content and function--the role of picture function is a more predominant and immediate concern to instructional technologists. Quite often decisions made by curriculum specialists or the nature of the lesson content itself may reduce the control an instructional designer has over what is to be represented in a particular picture. Even in those situations in which the designer has greater control over what is to be represented, the understanding of pictorial function is more vital, for any decisions made about content must be based on identifying the reason for a picture.

Just as one analyzes the instructional situation before selecting an appropriate medium, it is necessary to determine the role of a picture before deciding upon the content.

Previous Functional Approaches

While often overlooked, the potential functions served by pictures has not been completely neglected. One approach has directly or indirectly examined the potential functions of specific physical elements or attributes of pictures. Chute (1980) has suggested that to more completely understand the effects of color, additional insight into the nature of the various functions of color, such as cueing and gaining attention, is required. However useful, examining the functions of various physical or perceptual elements of a picture does little to further the understanding of how a picture, taken as a whole, functions in particular contexts. The approaches suggested by Chute, for example, can lead to an understanding of how color may be used to draw attentin to a given feature, but do not consider issues related to how well the entire picture, rather than a small component of the picture, serves its intended instructional function.

The ability of the symbol systems used by various media to serve functions has also been proposed. For the most part, advocates of this point of view (Gardner, Howard, & Perkins, 1974; Salomon, 1979; Levie, 1978) have emphasized the role that these symbol systems can serve in the development of cognitive skills. More specifically, Salomon (1979) posited that pictorial symbol systems can be used to encourage processes which take the place of, or supplant, other cognitive processes in learners who are deficient in those processes. Similarly, Salomon suggest that these symbol systems can be used to activate cognitive processes in learners who possess the ability to utilize a process, but are not skilled enough to recognize the conditions which require the process. While examining the functions of symbol systems in terms of cognitive development has considerable potential, such an approach has not given proper consideration to the diverse forms of behavior, strategies, and techniques represented in the instructional process. It must be pointed out that these comments are not intended to condemn research which has concentrated on symbol systems. Rather, it is to suggest that such research strategies can, at best, offer only a partial, and incomplete, understanding of the instructional role of pictures.

In contrast to those analyses of the functions of specific pictorial elements, there has been some inquiry into the instructional functions served by entire pictures. Although not directly referring to picture functions, Knowlton (1966) implied that pictures could function by representing objects or events, by providing analogies, or by describing logical relationships. Duchastel (1978) proposed three broad categories of picture functions: attentional, explicative, and retentional. That is, according to Duchastel, pictures can be used to either help gain student attention for the task at hand, help explain the content, and/or help students remember or retain what has been taught. Seven functions served by pictures to improve the recall of explicitly stated prose information have been identified by Levin (1981). Those functions range from the simple such as decoration or renumeration to the rather complex and sophisticated such as the "interpretation" function in which pictures help make the text more comprehensible and the "transformation" function in which pictures help make difficult prose more memorable. Among the several functions served by pictures which accompany textual material that have been identified by Levie and Lentz (in press) are those related to gaining and directing attention, affecting emotions and attitudes, and improving comprehension and retention.

While these attempts to identify the instructional functions served by pictures are meaningful departures from the traditional focus on physical and perceptual attributes, their potential for clarifying how pictures function in instructional settings is somewhat limited by several factors. First of all, many of the functions described above are so broad or general in nature that they add little to our understanding of the instructional roles served by pictures. Neglecting the dynamic nature implied by the term, such broadly conceived "functions" fail at the most basic level because they are not described in terms of the events and activities that occur during the instructional process. "Increasing prose comprehension", while a desirable instructional goal or outcome, does not provide an adequate explanation of how a picture is to be used to affect prose comprehension; many instructional factors are available which might account for the phenomenon of increased comprehension. Seemingly ignored by such broadly defined functions is the fact that effective instruction consists of numerous elements which help achieve desired outcomes. Thus in a single instructional sequence a picture may help increase comprehension by gaining attention, repeating vital information, presenting new information, providing additional examples, or in various other ways.

At the same time that some conceptions of pictorial functions are too broad, they are also, in another context, too narrow. This is best exemplified by Levin's (1981) conception of how pictures function in prose learning. In addition to being restricted by the placement of functions in a learning rather than an instructional perspective, the utility of Levin's functions is limited by the fact that it was designed for a specific instructional context--the recall of explicity stated text information. Yet instruction is concerned with, and appropriate consideration must be given to, outcomes related to other aspects of text learning (e.g., retention of information, making inferences, etc.) as well as nontext learning such as development of cognitive processes and attitudes.

The Nature of Pictorial Functions

To reduce the magnitude of the problems associated with those previously identified views of pictorial functions, as well as to expand the ability of pictorial research to be applicable to typical instructional situations, it is necessary to develop a clearer conception of the instructional functions served by pictures. A first step in the development of a lucid and comprehensible conception of pictorial function is the establishment of a set of criteria against which to evaluate potential functions.

Most importantly, potential functions must be stated in terms of their contributions to instructional processes and procedures. That is, each function should be representative of those planned or unplanned elements of the instructional treatment which tend to increase instructional effectiveness. The number and variety of these elements is substantial. For example, during instruction previous and appropriate knowledge and skills may be recalled, content organized, new information provided, examples and non-examples identified, specific points emphasized, analogies provided, appropriate cognitive skills modeled and encouraged. Some of these functions and those additional functions listed in Table 1 have long been considered appropriate for pictures. Few would deny that pictures can be used to clarify or simplify complex information or to provide specific, concrete examples of new concepts. Several functions listed in Table 1, however, have not traditionally been thought of as being appropriate for pictures or pictorial research. For example, pictures can be used to help recall previous learning, serve as advance organizers, model cognitive and visual processes, or summarize the presentation. The use of pictures to control or influence mathemagenic behaviors--those behaviors which increase learning--(Brody & Legenza, 1980) or to provide a context for learning (Bernard, et.al., 1981) are also representative of potential instructional functions that can bbe served by pictures. In other words, it appears that under yet to be determined conditions, consideration of the instructional roles that may be served by pictures can be expanded to include functions previously thought to be inappropriate.

Place Table 1 about here

In addition to identifying potential functions in terms of what occurs during the instructional process, it is also necessary to avoid the difficulties associated with identifying a discrete set of functions for each instructional context, domain, or discipline. Having a discrete set of picture functions for different instructional situations (e.g., learning from text, lecture, etc.), disciplines (e.g., science, English, mathematics) or types of learning (e.g., concept learning, psychomotor skills, attitude development) undoubtedly provides useful information in the areas under consideration. However, rather than increasing the utility of picture research, it is more likely that these divergent approaches will continue to make additions to the list of interesting things known about pictures rather than making meaningful contributions to the further development of a broad and generalizable conception of the instructional potential of pictures. Thus, instead of limiting functions to a specific form of instruction, every attempt was made to include in Table 1 those functions which are not only unique in terms of the instructional process they represent, but also broad enough to exemplify basic instructional functions which are applicable to a variety of instructional contexts. Emphasizing a specific aspect of a presentation, for example, is an instructional requirement that occurs in instruction having different outcomes (e.g., information acquisition, application, attitude change) as well as forms (e.g., lecture, discussion, independent study).

Several of the major limitations of previous approaches to pictorial functions are satisfied by the approach being suggested. Much of the uncertainty and confusion related to excessively broad categories of functions are reduced by having each potential function represent a smaller, more distinct instructional role. At the same time, by identifying the functions in terms of generic instructional behaviors and techniques, they are broad enough to be applicable to a wide variety of instructional contexts. Omitted from consideration as picture functions are general statements such as increasing comprehension or retention, which are more representative of the overall outcomes to be achieved by a picture rather than specific and precise instructional role to be served by that picture. The activation and supplantation of cognitive processes, two important concepts related to the potential of pictures to affect internal cognitive behaviors, are missing from the list of potential pictorial functions (Table 1) for similar reasons. Both supplantation and activation represent a final outcome to be reached after a picture functions in a specific manner. In other words, more basic instructional functions, such as modelling a process, are used to achieve the effect of supplanting or activating cognitive processes. The distinction between basic instructional functions served by pictures and those outcomes to be achieved by selecting and manipulating the functions, as well as demonstrating the instructional relevance of this approach, is underscored by the following example.

In studying how the energy crisis influenced our modes of transportation, a visual containing side-by-side representation of a 1962 and a 1982 automobile may be incorporated into the lesson. At one level, the picture may be used to help students acquire information by allowing them to make concrete and specific comparisons of various aspects of the automobiles. However, this same picture, either as part of this lesson or in another lesson, may also be used to help students develop their skills in making visual and/or nonvisual comparisons. Similarly, the same picture can be used to influence student attitudes towards the life styles represented in the picture. In other words, the ability of pictures to encourage comparisons affected three types of instructional outcomes: information acquisition, cognitive skills development, and attitude development.

Applying Functions to Research

Understanding and identifying the potential instructional functions that may be served by pictures, while necessary components of an approach to increase the utility picture research, are not sufficient to reach the goal. The emphasis on generic instructional functions could suggest the possibility of a closer relationship between the use of pictures and other instructional forms and techniques than normally envisioned by instructional technologists.

Integrating Pictorial and Nonpictorial Techniques

Traditionally pictures have been viewed as a unique form of communication, one that shares little with other forms of communication or instruction. As a result, pictorial research has become isolated from the larger body of instructional research, while research into instructional processes has similarly paid little attention to information generated by picture-based research. It is almost as if a line which may not be crossed has been drawn in the sand. Yet, such a position is seemingly in opposition to the scientific approach in general and, more specifically, to one of instructional technology's most basic tenets which implies that a medium (e.g., pictures) or technique is effective because it fulfills a basic communicative or instructional requirement rather than as a consequence of any inherent "magic." If this premise is indeed accurate, it would be naive to assume that in all cases there is only one way to meet any specific instructional requirement. The potential for several different mediums to fulfill selected instructional requirements is supported by both older conceptions of the media selection process (e.g., Briggs, 1970) as well as newer conceptions (e.g., Heidt, 1980).

The implications of this for research on the instructional functions served by pictures are considerable. Most important would be the need to develop relationships between pictures and other forms of instruction. These connections could be facilitated by examining the instructional functions served by pictures and comparing the results with research on nonpictorial strategies and techniques serving similar functions. Examining differences between verbal and nonverbal advance organizers or between the way pictures and vocal inflection direct attention are just two instances of comparing functionally equivalent instructional approaches. Such comparisons would do more than simply highlight similarities, but would also suggest differences between the various forms, thus expanding the data base from which instructional decisions are made. It should be pointed out that this approach would not only place visuals in their proper instructional context, but would also lead to a better understanding on the conditions under which picture, and only pictures, are most effective. Any generalizations--whether related to pictures only, nonpictures, or both--based on how pictures and nonpictures function in instructional settings would be more powerful and more useful than those generalizations based on a narrower perspective which isolate research on pictures from research on nonpictures.

While not in excessive quantity, some instances can be found where pictures were examined to determine whether they could serve functions usually associated with nonpictorial forms of instruction. Brody and Legenza (1980) suggested that pictures may serve a review function similar to the general review function served by questions that are placed after reading passages (Rickards, 1979). Even though advance organizers are usually operationalized in verbal symbols, Hartley and Davies (1976) reported that pictures could also serve this function. Although these and similar studies were not always primarily concerned with comparing instructional techniques that are seemingly different but functionally equivalent, their importance lies in the fact that they attempted to place picture functions in a broader instructional context by determining if pictures can serve functions that are similar to those served by nonpictures.

Applicability to Basic and Applied Research

The function-based approach to pictorial research being suggested could also help reduce the magnitude of one of the major concerns raised about the current products of research: the lack of relevance for practitioners. By acting as a core around which various forms and approaches to picture research revolve, the relevance and generability of picture research can be increased. As indicated previously, the utility of picture research suffers from the numerous and varied concerns of researchers and the apparent inability of one research issue to speak to the concerns of other issues. Dwyer (1978) has indicated that the diversity of interests and the lack of common terminology restricts not only the generalizabilty of picture research, but research in other media as well. In a sense, it is reminiscent of the difficulties encountered by ignoring the possibilities of nonpictorial research discussed above--narrow viewpoints and perspectives are unlikely to produce results which can be transferred to other forms of research and practice. Thus, the gap between research and practice remains wide.

However, instructional functions served by pictures is a versatile construct which has the potential to be the common denominator needed to help bridge the ubiquitous gap between research and practice. Whether as a central element of a study or as a point to be made regarding the importance of the study, pictorial functions can be applicable to basic research concerned with issues such as how pictorial information is processed, how pictures affect cognitive and perceptual processes and skills, and theory development and construction. At the same time, pictorial functions can be incorporated into applied research which is more concerned with discovering which instructional techniques work and under what conditions they are most effective, rather than why the technique works. Similar constructs used by both applied and basic research can only improve the utility and generalizability of both forms of pictorial research. By using similar constructs, the products of basic research will be more easily understood and used by those concerned with practice, while the knowledge gained through practice and applied research can be placed in a context that can influence more basic research (Figure 1). Without a common language or constructs, communication between the many forms of picture research will continue to be sparse.

Place Figure 1 about here

Picture Functions and the Instructional Environment

A major concern of research on picture functions must be the identification of those conditions which will allow a picture to function in the manner intended. That is, it is necessary to determine how picture functions are affected and influenced by the many elements which make up the instructional environment. One needs only to examine how even the simplest of messages are often misinterpreted to appreciate the complexities involved with ensuring that a picture functions in a manner congruent with the intentions of the designer. Merely indicating that a picture is to function as a way of presenting new information or as an advance organizer does not necessarily mean that the picture will actually function in such a way.

An understanding of how potential picture functions are influenced by the instructional environment must be based on a conception which asserts that pictures function as part of a complex, dynamic system. As such, they both affect other elements within the system as well as being affected by other elements. Thus, the effectiveness of a picture is not only dependent upon its potential functional role, its content, and its physical and perceptual characteristics, but is also dependent on its relationship with both the elements which make up the larger system and with the system itself.

When two images are placed side-by-side, sophisticated learners may make comparisons without any help from the teacher, while less sophisticated learners may need to be instructed to make the comparison. Thus, while the picture's function is to make comparisons, its success may depend on both the type of learner and teacher behaviors. Similarly, strategic elements such as time available to the learner and pacing may have considerable influence on how well a picture serves its intended function. If the time a picture can be viewed by the learner is limited, then a picture designed to direct attention to a specific feature of the lesson content or to clarify a complex idea may not be able to completely fulfill its designated role.

The manner in which a lesson is structured would also seem to have the potential to affect how well a picture functions. Failing to inform a learner when to look at a picture in a text may result in some students either ignoring the picture completely or looking at the picture at an instructionally inappropriate time, thus diminishing the likelihood of the picture serving its intended function. It also seems likely that a picture placed within a lesson that is structured and sequenced in a logical, orderly manner may function differently than the same picture incorporated into a lesson that is sequenced in a more abstract manner.

These are merely a few of the many ways in which the way a picture functions is not only dependent upon the characteristics of the picture itself, but also upon the many other components of the instructional system within which the picture operates. Other components which are likely to have some bearing on how a picture functions include, but are not limited to, the types of learning outcomes, student attitudes towards the content, previous experience with the lesson content, complexity of content, and teacher behavior.

While the relationships between a picture and the broader instructional environment is undoubtedly complex, a thorough understanding of these relationships is necessary for the development of a clear, and useful, conception of the instructional potential of pictures. The magnitude of this problem can be reduced somewhat by examining it in the comprehensive manner suggested previously. That is, rather than viewing the problem solely in terms of the instructional uses of pictures, it is possible to begin to understand some of the complex relationships, as well as to decrease the likelihood of conducting unnecessary research, by examining relevant research which includes both pictorial and nonpictorial techniques and strategies.

Functions and Physical Attributes

Although using nonpictorial research to improve the efficiency of pictorial research is valuable, it does not suggest that relevant pictorial reseach be ignored. Thus, in addition to developing an understanding of how picture functions are affected by the components of the instructional system within which it operates, research is also required to explore the relationships between picture functions and other pictorial elements. Most important is the need to determine how the ability of a picture to function in the desired manner is influenced by combinations of various physical and perceptual elements. While at first the differential effects of these elements seem intuitively obvious, it remains for empirical research to substantiate the nature and extent of the relationship between picture functions and pictorial design elements. This will not be easily or quickly achieved, for the questions which must be answered are numerous and complex. The manifold problems can best be exemplified by examining a single instructional situation where it has been determined that a picture is required to serve as an advance organizer. To help the picture function appropriately, decisions must be made on numerous pictorial elements including use of color, degree of pictorial complexity, degree of realism, number of noncriterial elements within the picture, use of long-shots or close-ups, etc. Although many of these elements have been the subject of research for years (Fleming & Levie, 1978), they have almost always been examined in terms of how much they assisted in the acquisition and retention of information, with little attention paid to how they helped the picture perform its intended function. As previously indicated, such an approach does little to aid in the development of a clear and useful conception of the instructional potential of pictures. On the other hand, in the function-based approach being suggested these pictorial elements are evaluated in terms of how well they help a picture serve a specific instructional function and how that the same function can be used to achieve a wide variety of learning outcomes. Here too, it must be pointed out, the influence of nonpictorial system components must be considered.

Summary and Conclusions

The major purpose of the function-based approach to picture research described in this paper is to help make research more relevant and useful to teachers, media specialists, instructional designers, and other practitioners. In spite of considerable research on various aspects of pictures and their instructional uses, a clear conception of the instructional potential of pictures is missing. As a result, practitioners who deal directly with the instructional process are limited in their ability to use pictures most effectively and efficiently.

Among the major elements of a function-based approach to pictorial research are the following:

1. Research must pay greater attention to the instructional role or function served by pictures. A determination of potential instructional functions served by pictures is basic to a clear understanding of the instructional role of pictures.
2. Potential functions must be described in terms of their contribution to instructional processes and procedures.
3. Functions must be applicable to a wide variety of learning objectives, strategies, and settings.
4. Instructional-function is a versatile construct that can be applicable to both basic and applied pictorial research.
5. Comparing how pictures and nonpictures can serve similar functions can lead to more powerful generalizations regarding the instructional role of pictures.
6. Research on instructional functions served by pictures should examine how the instructional environment influences the ability of a picture to serve its intended function.

7. Relationships between instructional functions and various pictorial elements must be explored. How combinations of various elements affect the ability of a picture to function in a prescribed manner is of primary concern.

While the need to increase the utility of picture research is clear, instructional technologists cannot expect researchers in other fields (e.g., psychology, mass communications) to find solutions to instructional problems. Rather, it is incumbent upon research generated by instructional technologists to provide the empirical evidence that can increase the ability of pictures to positively affect instruction. This is not to minimize the need for basic research; such research has a vital role to play in the development of a science of instruction. However, the appeal for increased utility suggests the need to consider placing basic research in a context which is more comprehensible to the practitioner. To the extent that the results of research are ignored by those most directly involved with the instructional process, the promise and potential of instructional technology will remain unfulfilled.

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Table 1

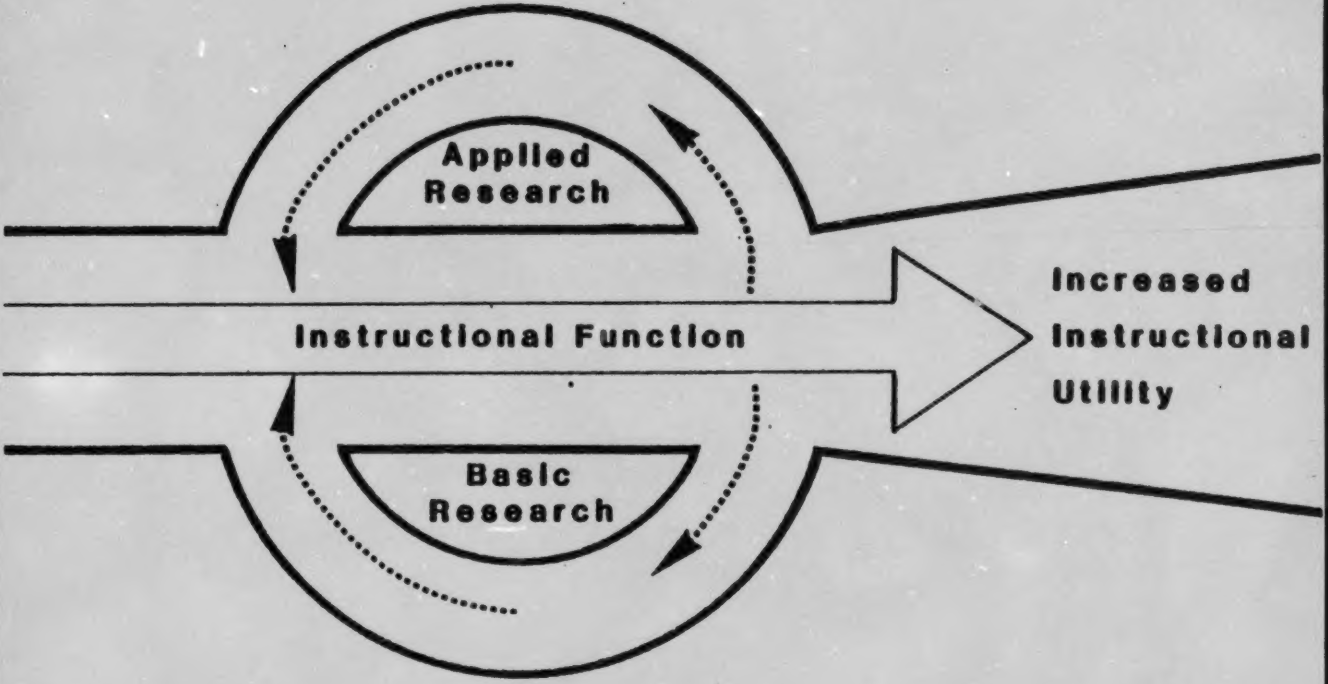
Representative Instructional Functions Served by Pictures

present new information
concretize abstract information
recall previous learning
compare
emphasize point
provide examples
motivate
clarify
control learner behaviors
common referent
model cognitive process

change of pace
isolate
simplify
organize
repeat
summarize
gain attention
direction attention
motivate
novel stimulus
provide analogy

Figure Caption

Figure 1. Use of instructional functions can increase the utility of pictorial research.


Applied Research
Instructional Function
Increased Instructional Utility
Basic Research

TITLE: The Effects of Three Methods of Information Cueing on the Retention of Visual vs. Verbal Instructional Materials: Further Investigation Into Encoding Specificity

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The Effects of Three Methods of Information Cueing on the Retention of Visual vs. Verbal Instructional Materials: Further Investigation Into Encoding Specificity

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INTRODUCTION

The present study represents a pilot research project investigating the psychological construct of encoding specificity. This pilot study was conducted during Spring Term 1982 at Ohio State University. The pilot study yielded partial support for the encoding specificity construct. However, the pilot study indicated that corrections in the design were needed. A follow-up study was conducted at The Pennsylvania State University, Fall Term 1982, which included a corrected experimental design. This follow-up study involved 300 subjects. Data is currently being analyzed from the follow-up study.

The following review considers the results and implications of the pilot study.

Rationale and Problem

The encoding specificity hypothesis, developed by Tulving and Thomson (1971) states that certain cues are encoded during learning, and that if these cues are available in the testing situation, recall can be facilitated. The encoding specificity hypothesis follows the now classic work by Tulving and Pearlstone on the availability versus accessibility of information in the cognitive structure (1966). What Tulving and Pearlstone concluded was that information can be available in the cognitive structure, but may not be immediately accessible, without the appropriate cue to spark recall or accessibility. It does not take a great deal of reflection to note that what Tulving and Pearlstone are describing is the very common psychological phenomena known as "Tip-of-the-Tongue" phenomena (Brown and McNeil, 1966). In other words, the human learner is capable of storing a large amount of information but if the appropriate retrieval cue is missing, the idea is temporarily lost. More recent research on the encoding specificity hypothesis confirms these original conclusions. Eysneck (1979) investigated the relationship betwen the encoding and decoding of information. He concluded that memory can be significantly effected by changes in cues from the learning situation and testing situation.

While the majority of the research work with encoding specificity is quite conclusive in support of the hypothesis, there has not been a significant amount of research done in this area using typical academic learning materials and testing materials. If one reviews the above cited work, the learning treatment and testing situations used to evaluate cueing (encoding specificity) effects, are quite removed from typical classroom instructional presentations and testing methods. Except for the Dwyer, DeMelo and Szabo study (1982), little applied research has been done in this area to address the interests of professionals involved with making decisions on improving instruction and testing conditions for classroom learning. Like much of the psychological research, the conclusions, while valuable, are difficult to apply because they are too far removed from the typical classroom environment. The current study attempted to address this problem by further investigating the encoding specificity hypothesis using a typical academic instructional presentation and testing conditions.

Experimental Design

The design of this study implied a 2 x 2 x 3 Lindquist type II experimental design. There were three variables investigated, two between-subjects, and one within-subjects.

The first between-subjects variable was type of instruction. There were two levels of the instructional variable:

(1) Visualized Mediated Instruction (VISU)
(2) Verbalized Mediated Instruction (VERB).

The content of the instructional programs represented a typical academic learning situation. The content was about the parts and operation of the human heart adapted from the Dwyer heart materials (Dwyer, 1967). The instructional programs were slide/tape presentations lasting 22 minutes. The audio tape was identical in both programs so both groups received the same amount of to-be-learned information. The difference between the VISU and VERB groups was in the slide portion of the presentation. Both groups saw the same number of slides in the same order. The VISU group saw a color illustration slide set with a verbal label identifying the relevant heart part on each slide. The VERB group saw a set of verbal label slides which consisted of a verbal label that named the heart part described in the audio portion of the instructional presentation. The VERB group had only verbally mediated instruction (i.e., word slide plus audio tape instruction).

The second between-subjects variable was the type of cueing measure during testing. This variable serves as the key to the encoding specificity issue in this study. There were three levels of the cueing variable:

(1) Free Recall Measure
(2) Visually Cued-Recall Measure
(3) Verbally Cued-Recall Measure.

All three measures had 21 possible correct answers. The free recall measure required the subject to list the 19 parts of the heart and the two heart phase names from memory. The visually cued-recall measure required the subject to write down the correct part name when he saw that part identified by an arrow on an illustration slide. To accomplish this, subjects saw the illustration slides of the heart with the verbal labels removed. Each slide had an arrow however pointing to the part in question. The slides used were identical to the VISU color illustration slide set used during learning except of course the labels (part names/phase names) were removed. The verbal cued-recall measure consisted of a list of 36 physiology names, including some "medical-nonsense" names. The 19 heart-part names and two phase names were embedded in this listing. The subject had to circle the correct heart part and heart phase names.

The within-subjects variable was delay of testing of one week. The same measures were used for the within-subjects variable.

Experimental Design

		Free Recall	Visually Cued-Recall	Verbally Cued-Recall
Immediate Testing	Visualized Instruction			
	Verbalized Instruction			
Delayed Testing	Visualized Instruction			
	Verbalized Instruction			

Results

Eleven subjects were dropped from the subject pool of 63 because of significant prior knowledge of heart physiology. Data analysis was done on 52 subjects, using an unequal n's analysis of variance, Lindquist II design. The following data resulted:

Source	Mean Squares	Df	f-Ratio	Probability
Between Subjects				
VISU/VERB Instruction(A)	192.271	1	8.725	.005
Cueing Type (B)	786.990	2	35.713	.001
(A) x (B)	100.478	2	4.560	.01
Error	22.036	40	-------	
Within Subjects				
Time (C)	37.837	1	11.640	.001
(A) x (C)	.272	1	.084	.8
(B) x (C)	5.365	2	1.650	.21
(A) x (B) x (C)	1.817	2	.559	.58
Error	3.251	40	-------	

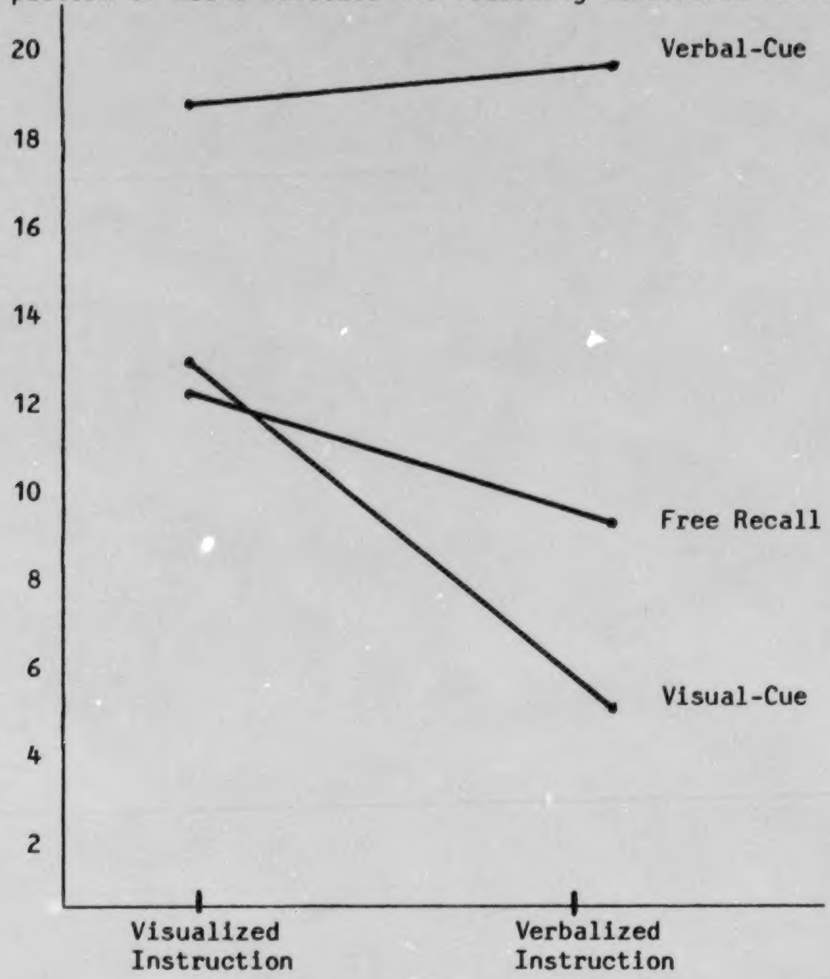
The instructional variable of visualized versus verbalized instruction yielded significant results (F, (1,40)df=8.725, p = .005). This result indicated that the visualized instructional heart program (X,VISU = 14.09) was significantly better for learning overall than the verbalized program (X,VERB = 11.20). This result fits past findings comparing visual and verbal instruction (Dwyer, 1978).

However, the crux of the study is the type of retrieval cueing that the three cueing measures provided. Each cueing condition - free recall, visual cues, verbal cues - varies in terms of its relationship to visualized or verbalized instruction, regarding encoding specificity. Analysis of the between-subjects variable of cueing type yielded significant results (F, (2,40)df=35.713, p = .001). Using a Tukey test, set a alpha = .01, indicated that the verbally cued-recall measure (X = 18.79) was significantly more effective in facilitating recall than both the visually cued-recall measure (X = 9.03) and the free recall measure (X = 10.88). The free recall and visually cued-recall measure did not differ significantly. This result is surprising at first glance, however, upon further analysis, it becomes more logical. The visually cued-recall measure and the free recall measure represent true recall testing conditions. However, the verbally cued measure is a recognition meaure rather than a true recall measure. Note that for the verbally cued measure, subjects were required to recognize the correct item from a list. They were not required to access the item from memory. Thus what was actually occurring here was recognition memory, not recall memory. Recognition memory is usually more accurate and less difficult than a recall type of memory. While this represents a basic flaw in the design of the pilot study, this flaw has been corrected in the follow-up study. In the follow-up study, the verbally cued-recall condition is a true recall condition. In the follow-up, the subject is presented a set of cueing slides during testing. Each slide contains the first three letters of the relevant heart part name (i.e., Epicardium = EPI, Endocardium = END, Tricuspid = TRI, etc.). The subject is then required to recall the correct part name that relates to the verbal cue presented. In this case, the subject is involved with recall memory rather than recognition.

Further anaylsis yielded a significant interaction between instruction type and cueing type, yielding partial support for encoding specificity effects. The significant first order interaction (F, (2,40)df=4.56, p = .01), resulted in the following pattern of means:

	Free Recall	Visually Cued-Recall	Verbally Cued-Recall
Visualized Instruction	12.06	12.31	18.43
Verbalized Instruction	9.69	5.75	19.14

This pattern of means revealed the following disordinal interaction:



A Tukey test set at alpha = .01 finds the source of the interaction to be with the visually cued-recall measure. Subjects receiving visualized instruction did significantly better with visual cues (X = 12.31) than subjects receiving verbalized instruction (X = 5.75). Subjects receiving verbalized instruction had their performance quite negatively effected by the visual cues in the visually-cued recall testing condition.

Conclusion

These results find partial support for encoding specificity and indicate that there is a significant relationship between mode of instruction and mode of testing, in terms of cues provided the learner during testing. In an applied sense, the learner's performance can be significantly effected if cues provided during the instructional presentation differ, or are similar to, cues provided during testing.

With the correction in the design of changing the recognition condition to a true verbal recall condition, it is likely that a similar interaction will occur between verbally cued recall and mode of instruction. However, the follow-up study data analysis is not yet completed.

It is clear from this partial support of encoding specificity that if visualized instruction is used, a visual component should be included in the testing condition. This visual component should be designed to provide relevant cues to the learner during testing. Relevant cues would be defined as those cues that are critical in defining the concept or fact being tested.

However, what these results clearly indicate is that if instruction is completely verbal, requiring the learner to transfer this instruction to a visual testing condition is not appropriate! Unfortunately, in classroom learning, and especially in industrial training, this is often the case. Instruction may be a lecture with some text reading but the learner may be evaluated when performing a psycho-motor skill, or in the case of industry, operating a complex machine. In such an educational or training situation, it is likely that the learner will take an inordinate amount of time to become competent with the skill or operation, and in many cases fail. This could account for the difficulty new employees in industry have when attempting to learn the correct operation of machinery, or other psycho-motor tasks, required to perform a skilled job.

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TITLE: The Relative Effectiveness of a Visual Advance Organizer and a Verbal Advance Organizer When Learning From Visual Instruction for Later Performance on Two Types of Learning Tasks

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The Relative Effectiveness of a Visual Advance Organizer And a Verbal Advance Organizer When Learning From Visual Instruction for Later Performance On Two Types of Learning Tasks

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Technology National Convention
New Orleans, LA, January, 1983

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Abstract

The present study investigated the relative effects of a visual advance organizer and a verbal advance organizer when learning from visualized instruction. Learning performance was measured on two learning tasks, a spatial task and a concept learning task. The cognitive style of field-dependents and field-independents was examined in this study. Results indicated that no difference occurred between type of advance organizer for the concept learning task. However, on the spatial learning task, the visual advance organizer was superior to both the verbal advance organizer and the control. The field-independent's performance was slightly better than the field-dependent's on both learning tasks, however, no interactions occurred with type of advance organizer. The results of this study imply that for psychomotor tasks in which labels or names and locations must be learned, visual advance organizers will tend to facilitate learning performance and are more effective than traditional verbal advance organizers.

Rationale and Problem

The present study investigates further the instructional strategy of advance organizers. The notion of advance organizers was originally researched by Ausubel (1960). The theoretical basis for Ausubel's advance organizer instructional strategy can be found in his theory on meaningful verbal learning (Ausubel, 1977). In essence, Ausubel refers to meaningful learning as having two components: psychological meaning and logical meaning. Psychological meaning refers to the idiosyncratic meaning that the individual abstracts from information. Logical meaning refers to the true meaning in the instructional information. For meaningful learning to occur, psychological meaning must be the same as logical meaning. The objective of the advance organizer instructional strategy then is to facilitate the match between logical meaning and psychological meaning. This can be accomplished when the advance organizer provides the learner with a cognitive framework for attaching new to-be-learned information to during learning. Additionally, the advance organizer will tend to stimulate previously stored relevant information in the cognitive structure which also facilitates information processing. Once this appropriate mental set has been established by the advance organizer, there exists a greater probability that meaningful learning will occur in contrast to the rote learning of isolated facts.

The general operational function of the advance organizer then is to prepare the learner psychologically for information to-be-acquired from the instructional sequence. However, there has been some question in the literature on whether the advance organizer facilitates the encoding stage of information processing or the retrieval stage (Mayer, 1979).

Two theories have been developed to address the encoding stage vs. the retrieval stage question (Mayer, 1975): assimilation encoding theory (AET) and assimilation retrieval theory (ART). AET states that the influence of the advance organizer on learning new material is to improve the encoding stage of information processing, while ART states that the advance organizer facilitates the retrieval stage of information processing. AET is tested by providing the learner with the advance organizer prior to receiving the instructional presentation. ART is tested by providing the learner with the advance organizer after receiving the instructional sequence but prior to testing. Studies evaluating these two research paradigms have indicated results favoring support of the AET (Lesh, 1976; Mayer and Bromage, 1979; Mayer, 1976). These conclusions would imply that the advance organizer facilitates the assimilation of information and that its locus of effect on information processing is at the encoding stage.

Ausubel (1968) has considered a variety of advance organizer types such as hierarchical organizers, expository organizers, historical organizers, and comparative organizers. These advance organizers are actually instructional strategies built into the instructional presentation. The advance organizer type used in the present study is the comparative organizer. When using the comparative advance organizer, the learner is given information prior to the instructional presentation that is analogous to material that must be learned and at the learner's present level of comprehension (DiVesta, 1976). The comparative organizer then has a direct relationship to the information the learner must later acquire but yet it has two distinct differences. First, the comparative organizer is inclusive in nature and is therefore not as detailed as the instructional information the learner must later acquire. Secondly, the organizer is at the learner's level of concreteness or understanding and therefore does not represent totally unique information. Looking at these two points, one can see how the comparative organizer would be capable of providing the learner with the two operational elements of an advance organizer: (1) a cognitive framework, (2) stimulation of relevant past memory in the cognitive structure.

Traditional advance organizer studies have investigated verbal advance organizers and their effects on learning verbal or mathematical information (Weisberg, 1970; Kahle and Rastovac, 1976; Jones, 1977). The present study attempts to move in a different direction and investigates the effectiveness of a visual advance organizer when the learner must learn from visual instructional materials. Additionally, traditional advance organizer studies have considered a number of possible interacting variables such as task difficulty, instructional sequence, lesson organization, and post-organizers (Shumacher, Liebert, Fass, 1975; Grotelueshen and Sjogren, 1968; Ausubel and Fitzgerald, 1962; West and Fensham, 1976). However, few past research efforts have considered innate cognitive variables (i.e., cognitive styles) and their possible interacting effects with advance organizer instructional strategies.

The present study examined the innate cognitive variable of field-dependents and field-independents and this variable's influence on the use of a visual comparative advance organizer. It is likely that a visual advance organizer would facilitate the learning of field-dependents whose information processing is characterized as global, non-analytical, difficulty in abstracting relevant from irrelevant information (Witkin, H. A., 1973). The visual advance organizer would provide the field-dependent learner with a cognitive framework to relate new information to. Such a cognitive framework would probably provide the field-dependent learner with cues to help him identify relevant information from the instructional presentation. This "pre-cueing" effect could facilitate the field-dependent's information processing by allowing him to more effectively separate relevant from irrelevant information.

Experimental Design and Procedures

The study implies a 2 x 2 x 3 Lindquist type-II analysis of variance having two between-subjects variables and one within-subjects variable.

An instructional program was used to evaluate the effectiveness of the comparative advance organizer. The program was a 2 x 2 slide tape presentation about the parts of the human heart and its phases. The program consisted of 39, 2 x 2 slides and a 22-minute synchronized narration. Heart drawings on the slides were detailed color illustrations with a part-name label. The heart program was adapted from Dwyer (1967).

The first between-subjects variable was the cognitive strategy variable of field-dependents-independents. There were two levels of this variable; the first level was field independents (FI), the second, field dependents (FD). To determine relative FI/FD, subjects took the Thurston's Closure Measure one week before participating in the experiment.

The second between-subjects variable was type of comparative advance organizer. There were three levels of this variable:

Level I: Advance Organizer-Visual

Subjects in this condition were told briefly about the use of advance organizers. They were then told that the visual advance organizer 2 x 2 black and white slides they will see had an analogous relationship to the heart instructional lesson. They then had 15 minutes to preview the advance organizer. The visual advance organizer consisted of 15, 2 x 2 slides showing the parts of a water filter pump and 1 slide showing the parts intact making up a completed pump system (see Figure 1). The pump system slide and 15 pump part slides had a direct analogous relationship to the parts of the heart in the heart instructional lesson. Each of the 15 pump part slides contained a label (e.g., name) for that particular part.

Insert Figure 1 Here

Level II: Advance Organizer-Verbal

Subjects were given the same information regarding advance organizers as Level I. They were then told that the advance organizer verbal labels that would be read to them had an analogous relationship to the heart instructional lesson. They then had 15 minutes to preview the advance organizer. The verbal advance organizer consisted of the 15 part names from the water filter system visual slides in Level I. The 15 pump part names were read aloud slowly several times by the experimenter. They then saw a diagram of the part names put together to form the complete pump system (see Figure 2).

Insert Figure 2 Here

The Level II group received the same type of advance organizer information as Level I but in a verbal form instead of a visual form.

Pump Filter System Visual

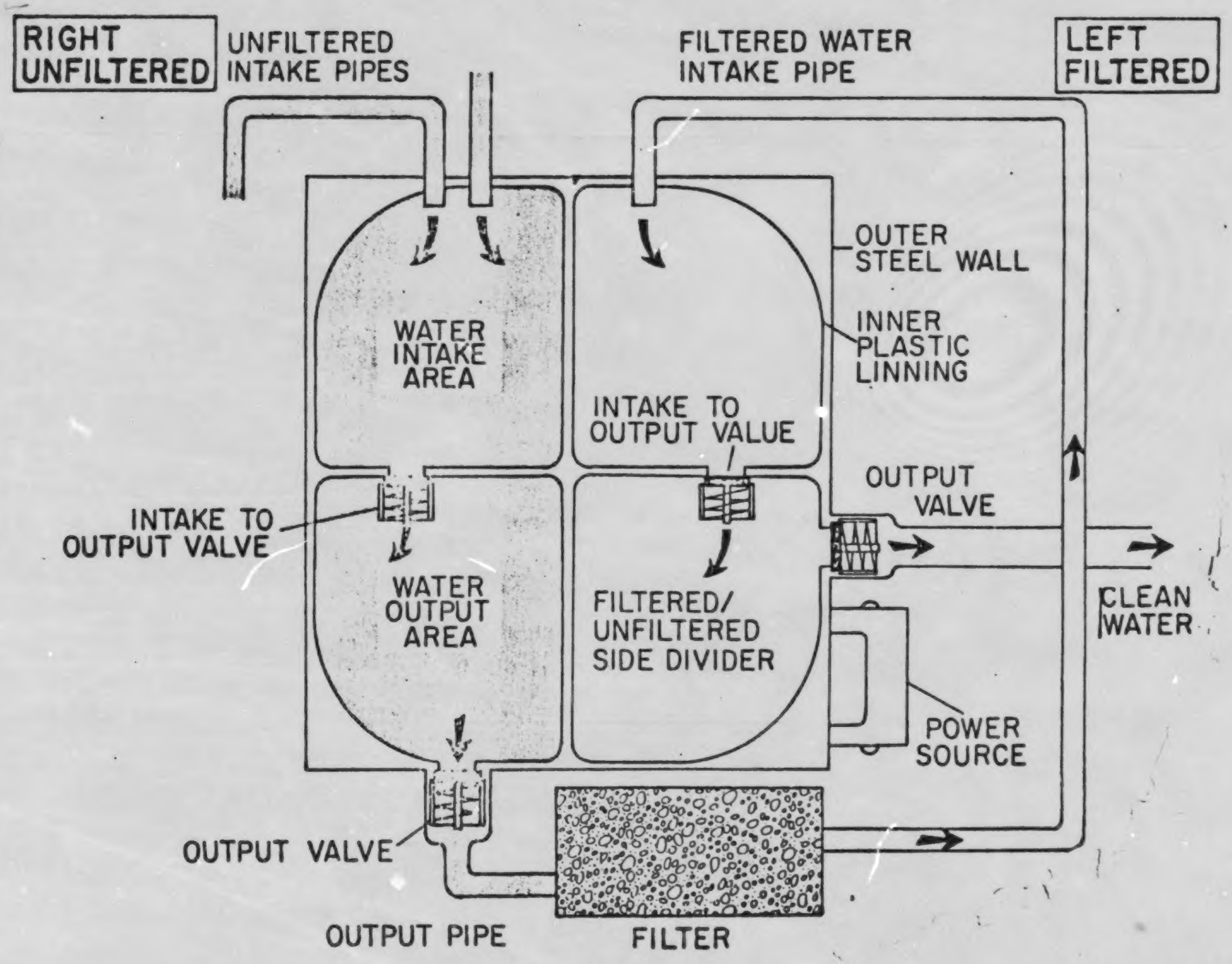
RIGHT UNFILTERED
UNFILTERED INTAKE PIPES
FILTERED WATER INTAKE PIPE
LEFT FILTERED
OUTER STEEL WALL
INNER PLASTIC LINNING
WATER INTAKE AREA
INTAKE TO OUTPUT VALUE
OUTPUT VALVE
INTAKE TO OUTPUT VALVE
WATER OUTPUT AREA
FILTERED/ UNFILTERED SIDE DIVIDER
CLEAN WATER
POWER SOURCE
OUTPUT VALVE
OUTPUT PIPE
FILTER

FIGURE 1

WATER FILTERING PUMP SYSTEM

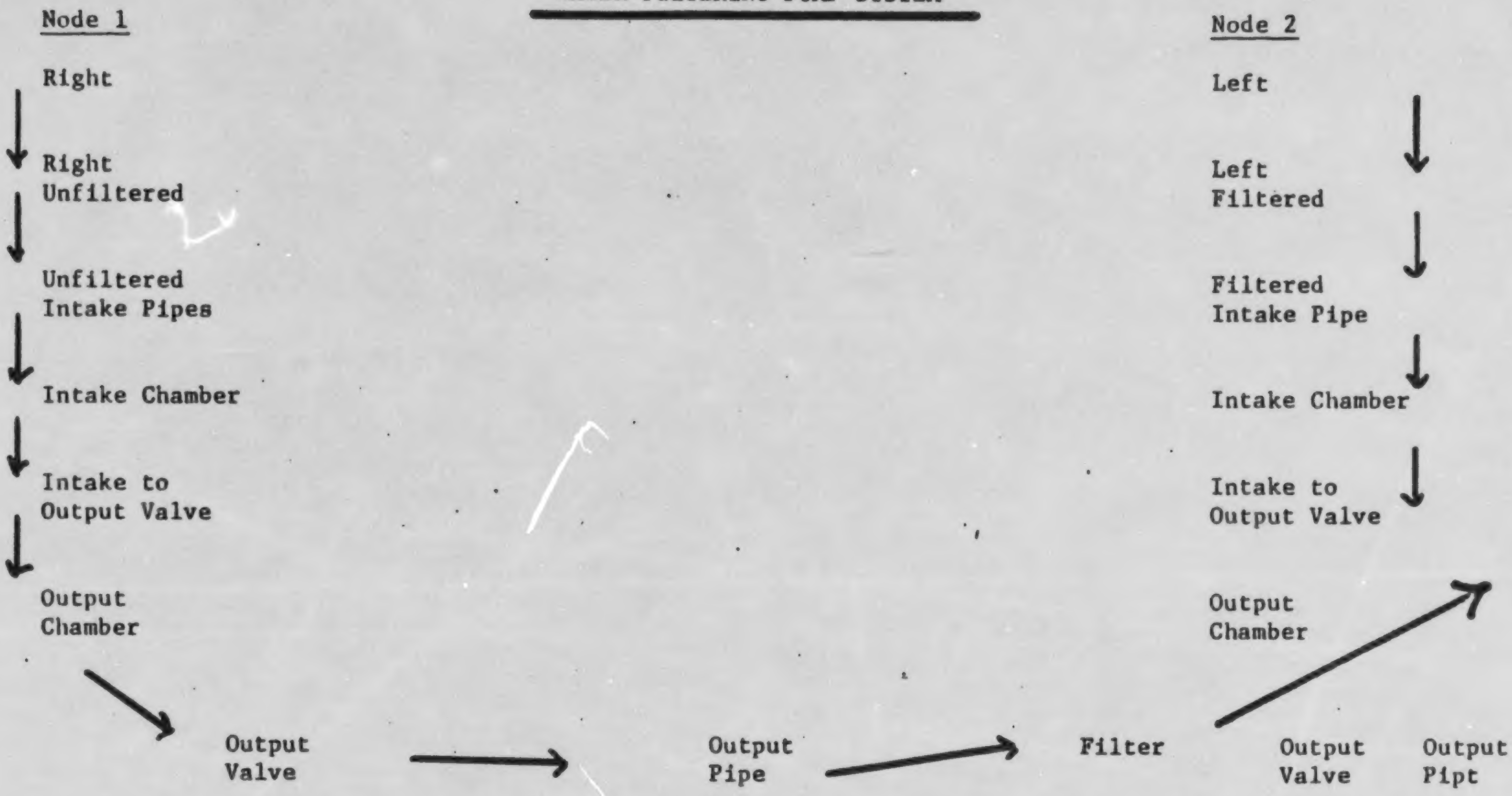
Node 1
Right
Right Unfiltered
Unfiltered Intake Pipes
Intake Chamber
Intake to Output Valve
Output Chamber
Output Valve
Output Pipe
Filter
Output Valve
Output Pipt
Node 2
Left
Left Filtered
Filtered Intake Pipe
Intake Chamber
Intake to Output Valve
Output Chamber

FIGURE 2

Control

To avoid contaminating effects due to the demand characteristic of groups working with the experimenter (e.g., Hawthorn Effect), the control group saw the visual slide set once. They were told that they were to evaluate the media quality of each slide. A discussion was then conducted for 15 minutes by the experimenter on the media quality of the slide set.

The within group variable was time of testing. There were three levels for the time variable: Immediate, One-week delay, Two-week delay.

The dependent measures represented two separate learning tasks. The first was a simple concept learning measure, the second a spatial learning measure. The concept learning measure contained 20 multiple choice questions on the instructional content from the slide tape program. The spatial measure evaluated the subjects' ability to remember the names of the heart parts and their correct location.

The subject pool consisted of 92 undergraduate and graduate students enrolled in the College of Education at the Ohio State University. Subjects received the Thurston's Closure Measure to determine their relative field-dependents-independents. From this subject pool, 78 subjects were selected to participate that clearly had FD/FI characteristics. There were 39 FD subjects and 39 FI subjects. From the original subject pool 14 subjects were eliminated because their scores on the Thurston's were not distinctly FD or FI but borderline.

The FD and FI groups were randomly assigned to advance organizer level. There were 13 subjects in each of the three advance organizer levels for the FDs and 13 subjects in each of the three advance organizer levels for the FIs.

Subjects were given their advance organizer training by the experimenter in 15-minute sessions. There were 3 separate 15-minute sessions for advance organizer training. FDs and FIs were combined for training, having 26 subjects in each of the three advance organizer sessions.

After all subjects received their advance organizer, during the next hour they viewed an instructional slide tape program on the parts and operations of the human heart. All 78 subjects saw the slide tape program on the heart at the same time. Immediately after the heart instructional slide tape program was presented, subjects were given the two dependent measures. One week later and two weeks later, the subjects were given the same two dependent measures. Attrition did not present a problem in this study since all the subjects were enrolled in a course and participation in a research study represented a required course activity.

Results and Discussion

Two separate data analyses were conducted. Analysis-I considered the results of the concept learning task. The concept learning task evaluated the learner's ability to respond to conjunctive concept items about information in the slide tape program. The concept learning task contained 20 multiple choice items. The results of the concept learning task are presented in Table 1.

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Insert Table 1 Here
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The field-dependent (FD) vs. field-independent (FI) variable approached significance (F (1,72) = 2.409, p = .12), indicating a

Between Subjects	Mean Squares	Df	f-Ratio	Probability
Field-Dependents-Independents (A)	101.350	1	2.409	.125
Advance Organizer (B)	14.577	2	0.346	.708
(A) x (B)	10.722	2	.255	.776
Error	42.075	72	-----	----

Within Subjects	Mean Squares	Df	f-Ratio	Probability
Time (d)	44.782	2	12.521	.000
(A) x (d)	1.029	2	.288	.75
(B) x (d)	1.339	4	.375	.83
(A) x (B) x (d)	.998	4	.279	.89
Error	3.577	144	------	----

Table 1, Analysis of Variance Table, Concept Learning Measure slightly better overall score for FI, ($\overline{X}$ = 10.71) over FD, ($\overline{X}$ = 9.39). The advance organizer variable did not yield significant differences, nor did the between groups interaction. The time variable yielded significance (F (2,144) = 12.521, p = .001). A Tukey follow-up test set at .01 alpha found the Immediate test ($\overline{X}$ = 10.92) to differ significantly from both the 1-week delay ($\overline{X}$ = 9.68) and 2-week delay ($\overline{X}$ = 9.55). Significant interactions failed to result with the within-group interactions. It is likely that the advance organizer conditions failed to have an effect on concept learning since the majority of the items on the concept learning measure directly related to the audio portion of the instructional program. The audio program described the operation of the heart (e.g., blood flow, valve operation) in detail. The advance organizer conditions tended to relate more directly to learning heart part names and their locations.

Analysis-II considered the results of the spatial learning task. The results of the spatial learning task are presented in Table 2.

- -

Insert Table 2 Here

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The spatial learning task required the learner to recall the heart part name and its correct location in the set of parts. The spatial learning measure consisted of an 8 x 11 sheet with a black and white illustration sketch of the heart and its parts. The learner had to label each part correctly. "Correctly" was defined as the appropriate part name in the appropriate location. There were 17 total points on the spatial measure. Results indicated that the FD vs. FI variable approached significance (F (1,72) = 2.146, p = .15), indicating a slight advantage for the FI ($\overline{X}$ = 7.93) over FD ($\overline{X}$ = 6.83). Significant

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Between Subjects	Mean Squares	Df	f-Ratio	Probability
Field-Dependents-Independents (A)	71.115	1	2.146	.147
Advance Organizer (B)	217.568	2	6.565	.002
(A) x (B)	.782	2	.024	.977
Error	33.139	72	-----	----

Within Subjects	Mean Squares	Df	f-Ratio	Probability
Time (d)	41.799	2	18.463	.000
(A) x (d)	4.269	2	1.886	.155
(B) x (d)	3.806	4	1.681	.158
(A) x (B) x (d)	.494	4	.218	.805
Error	2.263	144	------	----

Table 2, Analysis of Variance Table, Spatial Learning Measure

Advance
Organizer
Study ---
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ACS
Table 2

results occurred on the advance organizer variable ($\underline{F}$ (2,72) = 6.565, p = .002). A Tukey test set at .01 alpha found the visual advance organizer superior ($\overline{X}$ = 9.31) over the verbal advance organizer ($\overline{X}$ = 6.36) and the control ($\overline{X}$ = 6.48). The within group's variable of time was also significant ($\underline{F}$ (2,144) = 18.463, p = .0001). A Tukey set at .01 alpha indicates that the immediate test ($\overline{X}$ = 8.21) yielded better scores than the 1-week delay ($\overline{X}$ = 7.14) and 2-week delay ($\overline{X}$ = 6.48). In general, the results of the spatial learning task indicates a clear advantage for subjects receiving a visual advance organizer over a verbal advance organizer or control.

Conclusion

The results of this study imply that for spatial learning tasks in which the learner is required to remember locations of parts and names, visual advance organizers are more productively useful than verbal organizers or no organizers. This would be particularly true for visualized instructional programs. This conclusion has implications for industrial skill training situations in which much of what is learned is the spatial location of machine parts and the parts' correct name in an operational sequence.

It is likely that visual advance organizers would facilitate learning a variety of psychometer skills in which locations and specific labels had to be acquired. The visual advance organizer tends to provide the learner with an effective cognitive framework to relate new information to during learning. Additionally, it is likely that the inclusive visual advance organizer is able to stimulate relevant past knowledge in the cognitive structure, making effective encoding possible.

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TITLE: The Relationship of Field Dependence-Independence
to Dental Hygiene Admissions Predictors

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THE RELATIONSHIP OF
FIELD DEPENDENCE- INDEPENDENCE
TO DENTAL HYGIENE ADMISSIONS PREDICTORS

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INTRODUCTION

A variety of admission predictor measures are used in the student selection process for dental hygiene programs. A major test used by these programs is the Dental Hygiene Aptitude Test (DHAT). Developed in 1956, the DHAT has been subsequently revised and administered under the aegis of the American Dental Hygienists' Association (ADHA). However, as a part of cost saving measures, the ADHA has decided to discontinue administration of this test beginning in 1983. Thus, the need exists for identifying additional measures of potential success in dental hygiene programs.

Two tests have been selected for study as potential predictors. The present study is an attempt to determine whether measures of perceptual-cognitive style correlate with the DHAT and other typical predictive measures used in the dental hygiene admissions process. The two measures used in the study are the Group Embedded Figures Test (GEFT) and the Mirror Tracing Test (MTT). The GEFT is a recognized performance test which measures tendency toward a cognitive style of field dependence-independence. Field dependence-independence is a measure of an individual's cognitive style or the manner in which an individual perceives a part of a field as discrete from the surrounding field. Field dependent individuals' perceptions are strongly dominated by the prevailing field and they are less able to distinguish parts within a complex pattern; thus the tendency to perceive a field in a more global fashion. In contrast, field independent individuals have the tendency to perceive a perceptual field more analytically, experiencing items as discrete from the surrounding field and being able to overcome embeddedness (Witkin et al, 1977; Ausburn and Ausburn, 1978; Witkin, 1981).

A second, lesser known measure, which is investigated in this study is the Mirror Tracing Test (MTT). According to Suddick et al (1982), this test measures perceptual ability and appears to be related to field dependence-independence. Studies within the discipline of dentistry on the utility of the field dependence-independence measure and the mirror tracing test indicate that these two measures are useful in the admissions process.

A study by Suddick and his colleqgues (1982) found that field dependence-independence correlated with student performance in dental school. The authors used the Embedded Figures Test (EFT) and the MTT as measures of perceptual-cognitive style in 110 students at the University of Louisville School of Dentistry. The results indicated a relationship between these two measures. Thus, suggesting a new set of predictors to be considered for use in the student admissions process.

In a similar study, Wilson and others (1981) found a significant relationship between the same two measures and scores on the Dental Admissions Test (DAT). Results of this investigation indicated that field dependent individuals tended to score more poorly on the MTT and on final pre-clinic grades. Although the sample size was small (N = 20), the study resulted in significant correlations. These researchers concluded that measures of field dependence-independence could aid in determining motor skill deficiencies which subsequently could affect successful performance in dental school.

Although a variety of predictive measures are also typically used in the dental hygiene program admissions process, little research has been reported on their effectiveness. Studies which have been reported on the effectiveness of the DHAT indicated a relationship between these scores and first year success in dental hygiene. In addition, a comparison of the DHAT and the Scholastic Aptitude Test (SAT) indicated that the DHAT was a more effective predictor. The science, verbal and reading subtests of the DHAT were significantly correlated with grades (Hodges, 1980). The positive results of these studies indicated the usefulness of the DHAT as a dental hygiene admissions measure. However, because of the discontinuation of this test, it is imperative that investigations are undertaken to identify other effective performance predictors for admission.

The present study is the first phase of a larger investigation to be conducted in a effort to identify these more powerful, appropriate measures. Phase one, reported here, attempted to establish the relationship between measures of perceptual-cognitive style and other dental hygiene admissions measures. Given positive results in phase one, phase two will examine the predictive ability of these same measures for dental hygiene student performance while in the program.

METHOD

Subjects

Subject in the study were first year students (N = 47) enrolled in the Program in Dental Hygiene at the University of Minnesota during the 1982-83 academic year. All were female between the ages of nineteen and twenty-eight. Subjects entered the program with a diverse educational background; 42 percent having completed one year of college prior to entry and 38 percent having completed two years. The remaining have had less than one year or more than two years. The predental hygiene education was experienced at a variety of resident and nonresident community, state, and university institutions. Although subjects had a variety of educational experiences, they tended to have similar learning styles as measured by Kolb's Learning Style Inventory (1976). These particular subjects tended to be accomodator and diverger types of learners (Carrier and Newell, unpublished).

Instruments

The following dental hygiene admission predictors were used in the correlation analyses. Scores for each were recorded from subjects' application files.

- High school rank (HSR)
- College grade point average (GPA)
- Dental Hygiene Aptitude Test (DHAT)
    - Science
    - Verbal
    - Numerical
    - Reading
        - Composite

- Preliminary Scholastic Aptitude Test (PSAT)
    - Verbal
    - Math
- American College Test (ACT)
    - English
    - Math
    - Social Science
    - Natural Science
        - Composite

The DHAT includes the above mentioned subtests; each has a maximum possible score of nine. Scores on the subtests are also combined into an average composite score. Reliability coefficients range from .82 for the science subtest to .91 for the reading subtest (Hodge, 1980). Average correlation coefficients between the DHAT and first year grade point averages (GPA) of students entering dental hygiene range from .31 for numerical ability to .39 for science (ADHA, 1968).

Field dependence-independence was measured by the Group Embedded Figures Test (GEFT). This test involves locating a previously seen simple figure within a larger, more complex figure (Figure 1). The simple figure is viewed and then traced in the more complex figure. A total of eighteen figures are included in the test. A maximum of twelve minutes is allowed for completion of all tracings with performance being measured by the total number correct. Subjects who score above average on the test are defined as field independent and those scoring below average are defined as field dependent. The GEFT has a reliability estimate of .82 for both males and females (Witkin et al, 1971).

Insert Figure 1 about here

The Mirror Tracing Test (MTT) was designed to assess the development of fine psychomotor skills such as those used in dental hygiene. Although mirror tracing tasks have been used in psychology to demonstrate motor skill acquisition, few of these studies have been discussed in the literature.

The MTT requires subjects to trace six different geometric figures (square, circle, triangle, six pointed star, eight pointed diamond, and a complex z-shaped figure) while viewing the figure, as well as the hand in a mirror (Figure 2). Direct vision is prevented by a metal plate. All geometric figures are constructed of parallel lines between which the subject is instructed to remain while tracing the figure. Subjects trace as rapidly and as accurately as possible. Errors are recorded for tracings which exceed the boundaries. Both time to complete the task and number of errors are recorded.

Insert Figure 2 about here

Procedures

The GEFT was administered to the subjects during an orientation program for entering students Fall Quarter 1983. The test booklet and a number two pencil were provided for each subject. Students were instructed to find a simple figure within a more complex figure and outline its configuration accurately. After subjects completed practice problems the actual test was administered. Scoring was based on the number of simple forms correctly traced within the allowed time.

Subjects completing the GEFT were scheduled in groups of four to participate in the MTT at a later date during the quarter. The mirror tracing device, the test packet and a red pen were provided for each subject. Explanation of the tracing device and instructions for completing the tracing test were given. Subjects signaled a proctor when all tracings were completed and the elapsed time was recorded. Number of errors and elapsed time were determined as the measure of performance.

Results

The Pearson product-moment correlation in the Statistics Package for the Social Sciences (SPSS) was used for the data analysis (Nie et al, 1975).

Table I illustrates the means and standard deviations for the various dental hygiene predictor scores, the GEFT and the MTT. Across tests, entering dental hygiene students tended to exhibit stronger skills in science and math as compared to verbal and social science skills.

The results also indicate that dental hygiene students have a mean GEFT of 12.04 with a standard deviation of 3.83. The mean established for women college students by Witkin and colleagues (1971), however, is 10.8 with a standard deviation of 4.2. Thus, this dental hygiene group as a whole tended to be more field independent than the norm group.

Table I also illustrates the means and standard deviations for the MTT - elapsed time ($\overline{X}$ = 7.27, s.d. = 2.36) and MTT - errors ($\overline{X}$ = 39.72, s.d. = 38.22). The range of scores for MTT - errors was between 2 and 131.

Insert Table I about here

The correlation analyses revealed a significant correlation between GEFT and DHAT scores in the science, verbal and reading subtests ($r = .33$, $p = .012$; $r = .40$, $p = .003$; $r = .40$, $p =.003$ respectively). The GEFT was also significantly correlated with the composite DHAT ($r=.44$, $p = .001$). There was no significant correlation between GEFT and the numerical subtest of the DHAT (Table II).

GEFT and entering GPA were correlated ($r = .29$, $p = .02$) as was GEFT and PSAT - Math Score ($r = .43$, $p = .01$). As a follow up test, the chi-square test was applied and analysis of data indicated a significant relationship between GEFT and PSAT - Math Score at the .006 level ($X^2 = 93.31$, $df = 84$). However, PSAT - Verbal Score, ACT Scores and high school rank (HSR) were not significantly correlated with the GEFT (Table II).

Table II also illustrates that the GEFT was inversely and significantly correlated with MTT - errors ($r = -.23$, $p = .04$). Thus as numbers of errors increased, scores on the GEFT decreased indicating a relationship between an increase in errors and a tendency toward field dependence.

Similarly, the GEFT scores were inversely related to MTT - elapsed time ($r = -.23$, $p = .06$), however this relationship was not of statistical significance at the .05 level. As elapsed time increased GEFT tended to decrease, indicating somewhat of a relationship between elapsed time and a tendency toward field dependence.

Noted in Table II is the positive correlation between the MTT - errors and MTT - elapsed time (r = .39, p = .003). This significant relationship indicates that as errors increase, so does the elapsed time. In other words, individuals who do well with accuracy, also do well with speed.

Insert Table II about here

Discussion

Dental hygiene students were found to be more field independent than typical college students (Witkin et al, 1971). This finding supports the research conducted by Suddick et al (1982) which also found that dental students tend to be highly field independent. Although the present study did not investigate the predictive quality of the GEFT for success in a dental hygiene program, the results of studies with dental students indicated that field independent individuals tend to have an advantage in a dental school clinical curriculum. Because dental and dental hygiene students perform many similar tasks such as working with dental mirrors for indirect vision, one might suppose that field independent dental hygiene students would also be more successful in the clincial portion of a dental hygiene curriculum. A study by Melk and Skubic (1971) also supports this premise. They found that individuals who are poorly skilled in certain motor skills tend to be field dependent.

It is interesting to note the positive correlation between the GEFT and DHAT. As mentioned previously, this study was undertaken in an effort to identify effective admissions measures to replace the DHAT. Successful completion of a dental hygiene program rests in an individual's general ability, but more specifically in one's ability to understand the sciences. Thus, the correlation between GEFT and DHAT - science subtest is of particular interest. These positive results are supported by other research which indicates that field independent students typically perform better in math, science, and engineering than field dependent students (Witkin, 1977; Guilford, 1980).

The positive correlation between GEFT and GPA is also pertinent. While GPA is usually considered predictive of success in college in general, the correlation between GEFT and GPA in this study was based on prerequisite science courses.

Of particular interest is the inverse but significant correlation between the GEFT and the MTT - errors and elapsed time. In other words, students who are highly field independent completed the MTT with accuracy and speed. The large distribution of scores for the MTT - errors should also be noted. This range of scores suggests that extreme subgroups may exist, such as those who have few errors and low time and those with high number of errors and high time. A future study needs to look at these extreme groups and how these scores correlate with the other measures.

With the MTT time and error correlation, it is noted that students who completed the test quickly were also those with more accuracy. This suggests that accuracy may be due to some other factor than length of time. A future study may be indicated to identify those variables.

The overall findings suggest that the field independent individual is more likely to succeed in a curriculum which is based on one's ability to learn to work in a visual field which is very complex. Valid, reliable and easily administered predictor measures could, not only aid in selecting students who are more likely to succeed in a dental hygiene program, but could also lead to improved predental hygiene counseling and to early diagnosis of motor skill weaknesses once students are enrolled.

Directions for Future Studies

Although the results of this study indicated that field independent individuals may have an advantage in completing a dental hygiene curriculum, subsequent investigations need to focus on a determination of the predictive utility of the GEFT and the MTT for student performance in various aspects of a dental hygiene program, eg. clinical performance. In addition, future studies might address the issue of group administration vs. individual administration of the MTT. The purpose being to identify whether or not those who finish the test quickly have an effect on the time taken by the other subjects.

Overall, results of studies like this one have an impact on educational decisions, such as do we provide instructional support for students who do poorly or do we counsel them out of particular programs.

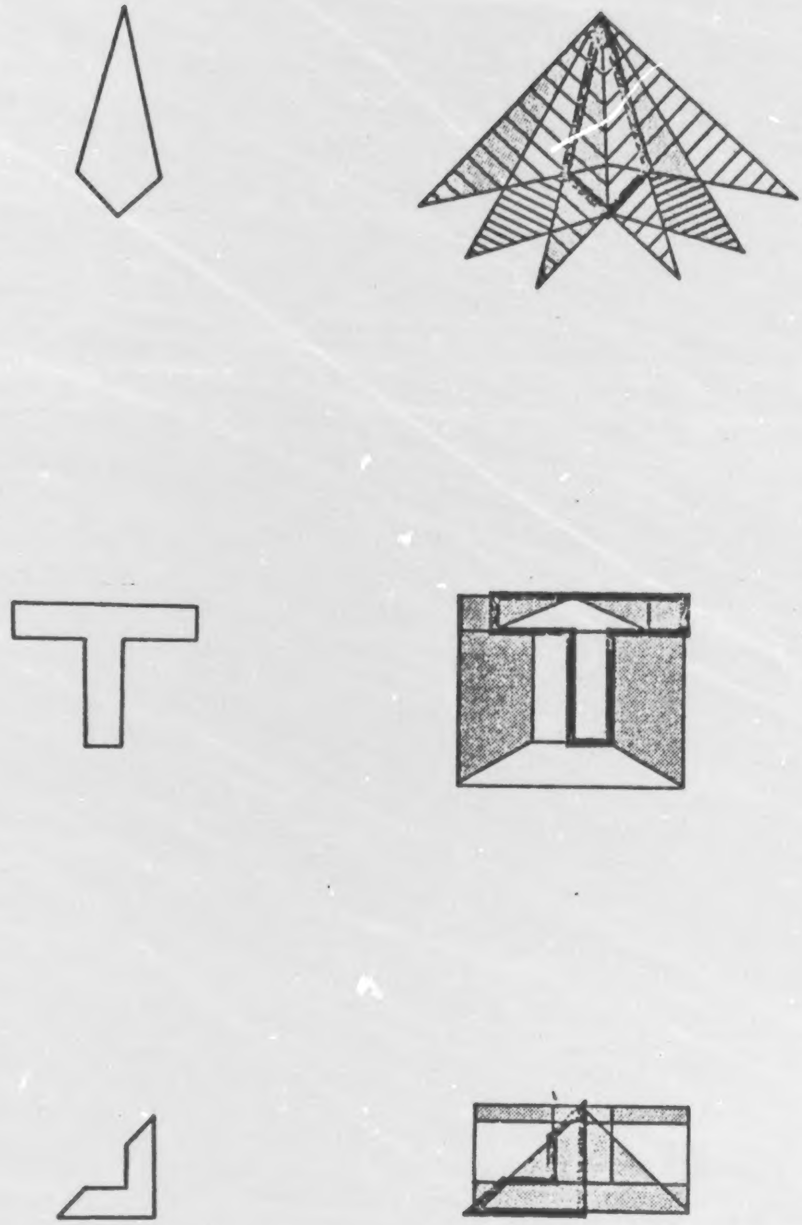

FIGURE 1: GROUP EMBEDDED FIGURES TEST GEOMETRIC FIGURES

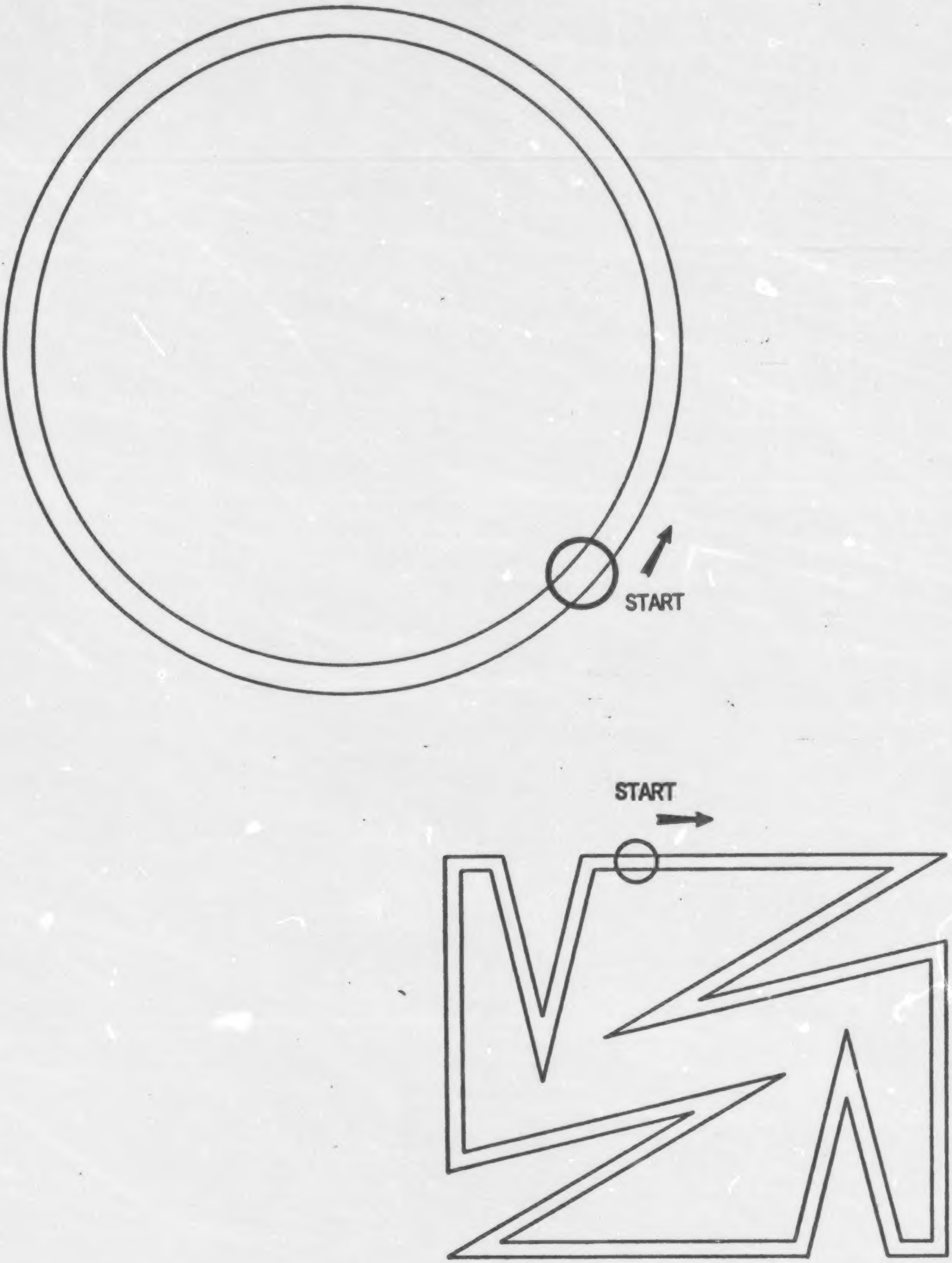
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FIGURE 2: MIRROR TRACING TEST GEOMETRIC FIGURES

TABLE I

MEANS AND STANDARD DEVIATIONS FOR DENTAL HYGIENE PREDICTOR SCORES, GEFT SCORES AND MTT SCORES

TYPE OF MEASURE	TOTAL SCORE POSSIBLE	$\overline{X}$	S.D.
High School Rank (HSR)	99	70.94	19.89
Grade Point Average (GPA)	4.00	2.69	.35
Dental Hygiene Aptitude Test (DHAT)			
Science	9.00	5.09	1.61
Verbal	9.00	4.49	1.60
Numerical	9.00	5.07	1.91
Reading	9.00	4.82	1.96
Composite	9.00	4.89	1.31
Preliminary Scholastic Aptitude Test (PSAT)			
Verbal	80.00	40.39	6.07
Math	80.00	45.68	6.34
American College Test (ACT)			
English	33.00	18.52	3.79
Math	36.00	19.31	6.70
Social Science	34.00	16.72	4.81
Natural Science	35.00	21.45	3.79
Composite	35.00	19.14	3.78
Group Embedded Figures Test (GEFT)	18	12.04	3.83
Mirror Tracing Test (MTT)			
Elapsed Time	20 min.	7.27	2.36
Errors	2-131*	39.72	38.22

*Note: Subjects' range of scores

TABLE II

RELATIONSHIP BETWEEN GEFT SCORES AND DENTAL HYGIENE PREDICTOR SCORES AND MTT SCORES AND RELATIONSHIP BETWEEN TWO MEASURES OF MTT SCORES

GEFT SCORES

OTHER MEASURES	r value	p value
HSR	.20	.109
GPA	.29	.02
DHAT		
Science	.33	.012
Verbal	.40	.003
Numerical	.15	.16
Reading	.40	.003
Composite	.44	.001
PSAT		
Math	.43	.01
Verbal	.28	.08
ACT		
English	.08	.34
Math	-.01	.48
Social Science	-.22	.13
Natural Science	.29	.06
Composite	.02	.45
MTT		
Elapsed Time	-.23	.06
Errors	-.23	.04
MTT Elapsed Time/Errors	.39	.003

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TITLE: Effect of Visual Testing in Detecting Significant
Interactions Among Instructional Variables

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Effect of Visual Testing in Detecting Significant Interactions Among Instructional Variables

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Abstract

The purposes of this study were to empirically investigate the effectiveness of two evaluation strategies (visual and verbal) in detecting the existence of main effects and interactions resulting from visualized instruction. One hundred fifty-one students at The Pennsylvania State University were randomly assigned to one of sixteen treatment cells constituting two parellel (2x2x2) factorial design. Students received the four individual criterion tests immediately after receiving their respective instructional units and then again two weeks later to obtain a measure of delayed retention. Results obtained in this investigation clearly demonstrate the superiority of visual tests as a means of assessing the instructional effect of visualized instruction and their value as criteria for detecting main effects and interactions among instructional variables defined in terms of visual and nonvisual characteristics.

Introduction

A number of educational researchers (Salomon & Clark, 1977; Clark & Snow, 1975; Clark, 1978) have indicated that conventional experimental designs applied to educational problems have not been very successful in providing understandings of the type necessary for educators to effectively manage the teaching-learning process. Dwyer (1978) in reviewing the results of more than 650 articles related to visual learning and information processing concluded that (a) the use of specifically designed visual materials in the teaching-learning process does facilitate increased student achievement, and (b) words and pictures are not processed in the same way nor are they equally effective in facilitating student achievement of different educational objectives. The effectiveness of visualization in the learning process has been attributed to the fact that visualized information can be processed simultaneously on several levels (Paivio, 1971; Nelson, et al., 1974; Posner & Warren, 1972; Jacoby, 1974; Tulving, 1976). This contention, they suggest, is possible because sensory-feature processing need not unfold in lockstep fashion with antecedent features. The fact that visual information can be processed on several levels simultaneously enhances its entry into long term memory.

Implications derived from this position would indicate that in learning environments where visualization was used in the instructional (encoding) process and was not used in the retrieval (decoding) process, learner performance measures would yield gross underestimates, if not distortions, with respect to what and how much information had been originally acquired. Specifically, there is both theory and research which contends that the level and quality of cognitive information processing that is facilitated by the use of mediated (visualized) instruction cannot be validly assessed via the use of verbal testing strategies.

Problem Statement

Visualization is: (a) being used extensively in the teaching-learning process, (b) can be designed to facilitate increases in student achievement, (c) capable of being processed simultaneously on several cognitive levels, and (c) not being used in the testing or evaluation modes of information retrieval. The objective of this exploratory investigation was to evaluate the sensitivity of two criterion dependent variables (students' performance on a visual or nonvisual version of an achievement test), used in two similar experimental designs to assess the number of main effects and interactions between and among the independent mode of instruction (visual or nonvisual), order of drawing test (before or after verbal/visual achievement test), and mode of drawing test (verbal cued or free recall). Two specific questions provided the focus of this study:

(a) Which evaluation strategy (visual vs. verbal) would detect the larger number of main effects of the independent variables on both the immediate and the two week delayed retention tests?

(b) Which evaluation strategy (visual vs. verbal) would detect the larger number of interactions between and among the independent variables on both the immediate and two week delayed retention testing?

Theoretical Justification for Visual Testing

Probably, the oldest and least controversial fact that can be derived from the research on human learning is that any change in the retrieval (evaluation) environment from that which occurred in the original learning environment procedures marked decrements in learner performance (Nitsch, 1977;

Battig, 1979). In this regard Lindsay and Norman (1977, p. 337) have stated that in the teaching-learning environment, "the problem in learning new information is not in getting the information into memory; it is making sure that it will be found later when it is needed." Consequently, information retention level is assumed to be a direct function of the encoding occurring at the presentation stage and the degree to which the retrieval environment recapitulates this encoding (Battig, 1979; Tulving, 1979).

Optimum validity in cognitive assessment of learner information acquisition, apparently can only be obtained, if there is a high degree of congruency between the number of common features in the presentation (encoding) mode and the retrieval (evaluation) mode of instruction, e.g., if visualization is an integral component in facilitating learner encoding of the information, than visualization should also be used in the test items (decoding phase) used to assess learner achievement. Tulving and Thomson (1973, p. 359) have stated that, "only that can be retrieved that has been stored, and that how it can be retrieved depends ultimately on how it was stored." Research by Winograd and Conn (1971), Thomson (1972), Kolers (1973), Tulving and Thomson (1973), Tulving (1976), Battig (1979) and Jacoby and Craik (1979) can be cited in support of this position.

One of the perennial problems associated with the teaching-learning process is the determination of how learners acquire, store and recall information. As a result, a number of information acquisition strategies have been proposed which attempt to explain how learners acquire and retrieve information. For example, Tversky (1969, 1973) has found that verbal and visual information are encoded differently depending on the learner's perceived use of the information. Glanzer and Clark (1963b) have advanced the notion of a single information processing system (verbal-loop hypothesis) which contends that visual information is translated into a stored in verbal/symbolic form. When this information is to be retrieved, it is retranslated from the verbal symbolic form back to the original visualization. A number of specific research studies have been conducted which can be interpreted to be supportive of this orientation (Glanzer & Clark, 1963a, b, 1964; Lantz & Stefflre, 1964; Smith & Larson, 1970). However, there are many different kinds of evidence indicating that the internal representations of pictures is in itself not verbal (Gehring, et al., 1976; Loftus & Bell, 1975).

Paivio, Rogers and Smythe (1968) have suggested the possible existence of dual encoding and retrieval systems each functioning as a separate entity with the capability of working in unison with each other. Basically, this orientation (Paivio, et al., 1968; Paivio, 1971) proposes a model involving two independent memory systems: one having the capability of processing verbal symbols, the other having the capability of processing visual information. In essence, the dual code theory claims that information is stored in long-term memory in terms of visual images and verbal representations (Anderson, 1980). Although the dual encoding and retrieval systems are perceived as functioning as separate entities, they also possess the capability of functioning in unison with each other. Depending on the nature (form) of the information to be retrieved, action with the specific memory system would be initiated (Dwyer, 1978). Similarly, a number of research studies have been conducted which may be interpreted as being supportive of the dual encoding and retrieval systems (Bahrick & Boucher, 1968; Paivio & Csapo, 1969; Bahrick & Bahrick, 1971; Cermak, 1971; Ternes & Yuille, 1972; Levie & Levie, 1975).

The justification for using visual testing in situations where visualization is used to complement oral/print instruction appears to have its generic roots in the sign similarity hypothesis and the cue summation principle of learning. In general, the essence of the cue summation principle of learning is that (Severin, 1967b, p. 237): "...learning is increased as the number of available cues or stimuli is increased." The strategy of attempting to use visualization both in the presentation and evaluation phases of instruction is an attempt to implement the stimulus generalization phenomenon which contends that the amount of information that will be acquired by students increased as the testing situation becomes more similar to the situation in which the students received their instruction (Hartman, 1961; Severin, 1967a). In this regard Paivio (1971, pp. 60-61) has indicated that "images are more likely to be directly evoked by concrete [illustrations] than by abstract words" would seem to be further justification for the use of visualization in testing.

Materials and Procedures

The content material used in this study was a 2,000-word instructional unit describing the human heart, its parts, and the internal processes that occur during the systolic and diastolic phases (Dwyer, 1972). This content was selected because it permitted evaluation of several types of learning objectives. The instructional content was developed to reduce and control, as much as possible, deficiencies identified in previous media research. For example, specific types of educational objectives to be achieved were identified; a specific content area that permitted meaningful learning to occur was selected; three criterion tests measuring student achievement of different types of educational objectives were constructed; and visualization was systematically integrated into the verbal content material. In addition, student performance on the individual criterion tests was analyzed item by item to determine where students had difficulty. Thirty-seven such areas were then traced back to the points in the instructional script where the information necessary to achieve on these items was originally presented. Once these difficulty areas had been identified, visuals were designed specifically to illustrate the information in each of the 37 critical areas. Students receiving the nonvisual mode of instruction interacted with the 2,000-word instructional unit in a self-paced booklet format which contained no illustrations. Students who interacted with the visualized mode of instruction received the same verbal content as did students who received the nonvisual mode; however, their self-instructional booklets were complemented by 37 visual illustrations.

Criterion Measures

Each student in each treatment participated in one of the instructional presentations and took three separate, 20-item criterion tests. Scores on the three individual criterion tests were combined into a 60-item total criterion test score. The following description of the kinds of performances measured by the criterion tests illustrates the kinds of educational objectives assessed in this study.

Drawing Test

This test had as its objective the evaluation of the subjects ability to construct and/or reproduce items in their appropriate context. For example, the test (N=18) items provided the students with a numbered list of items, e.g., (1) superior vena cava; (2) aorta; (3) tricuspid valve; (4) pulmonary vein; etc. corresponding to the parts of the heart presented in the instructional unit. The subjects were required to draw a representative diagram of the heart (a symbol like a valentine sufficed; the quality of the drawing did not enter into the scoring) and place the numbers of the listed parts in their respective positions. In this test, the emphasis was on the correct positioning of the verbal symbols with respect to one another and to their concrete references. The drawing tests used in this study existed in two versions: the verbal format (Figure 1, Plate B), because it listed the parts of the heart to be positioned, was called the Verbal Cued Version. The Free Recall Version (Figure 1, Plate A), contained the same directions as the Verbal Cued Version but did not contain a listing of the parts of the heart to be positioned.

Figure 1 About Here

Identification Test

The objective of the identification test was to evaluate the students' ability to identify parts or positions of an object. This multiple-choice test required students to identify the numbered parts on a detailed drawing of the heart. Each part of the heart that had been discussed in the presentation was numbered on the drawing and appeared in a list on the answer sheet. The objective of this test was to measure the students' ability to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.

Terminology Test

This test consisted of 20 multiple-choice items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas that have as a prerequisite to the more complicated types of learning a comprehensive understanding of the basic elements (terminology, facts, and definitions) indigenous to the discipline.

Comprehension Test

The comprehension test also consisted of 20 multiple-choice items. Students were given the location of certain parts of the heart at a particular moment of its functioning and asked to locate the position of other parts of a heart at the same point in time. This test required that students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding that occurs when an individual understands what is being communicated and can use the information to explain some other phenomenon occurring simultaneously.

Total Criterion Test

The items contained in the three criterion tests were combined into a 60-item total criterion test. The purpose of this test was to measure the students' understanding of all the content material presented in the instructional unit.

The format of each of the 60 multiple choice items in the identification, terminology, and comprehension tests was a verbal stem with verbal response options. The visual version of this test was constructed so that for each of the 60 verbal items there was a matching visual item. For each of the response options on each of the 60 multiple choice items an "equivalent" visual distractor was constructed. The stem of both the verbal and visual test questions were verbal and asked the same question; however, the stems of some of the visual test items were modified slightly to make them appropriate to the visual distractors. Figure 2 presents a sample of the verbal and visual formats for an item on the comprehension test.

Figure 2 About Here

Design

One hundred fifty-one undergraduate students enrolled at The Pennsylvania State University were randomly assigned to one of sixteen treatment cells generated by the two parallel 2x2x2 factorial designs. Figure 3 shows this design and number of students in each cell. The three independent variables were (a) mode of instruction (visual or nonvisual), (b) order of Drawing Test: administered before or after completion of the three individual criterion tests, and (c) mode of Drawing Test: free recall and verbal cued recall. The dependent variables were students' performance on the visual version of the achievement test for one design, and students' performance on the nonvisual version of the achievement test for the other. The dependent variables for both forms of the achievement tests (visual and nonvisual) were (a) performance on the Drawing Test, (b) performance on each individual criterion test (Identification, Terminology, Comprehension), and (c) performance on the Total Criterion Test, 60 items. Students received the individual criterion tests immediately after receiving their respective instructional units and then again

Figure 3 About Here

two weeks later to obtain a measure of delayed retention. ANOVA statistical designs were conducted on each criterion measure. Where significant F ratios (.05) were found, differences between pairs of means were analyzed via Tukey's W-Procedure.

Results

Table 1 presents the means, standard deviations, and reliability coefficients for students receiving the verbal and visual test formats for each criterion measure. Table 2 depicts the main effects obtained on each criterion test for both the immediate and delayed testing on the visual (Plate 1) and nonvisual (Plate 2) versions of the achievement tests. Where significant differences in student achievement occurred the critical areas were found to be: (a) the mode of instruction favoring visualized instruction, (b) order of drawing test favored testing after receiving the individual criterion tests, and (c) mode of testing favoring the verbal cued format.

Table 1 About Here

Table 2 About Here

The 2x2x2 analysis of variance design conducted on the independent variables indicated that one interaction occurred on the nonvisual immediate achievement tests (drawing, ($F = 6.31$, df = 1/67, $p. < .01$), and four interactions occurred on the visual achievement tests (identification, ($F = 5.18$, df = 1/68, $p. < .05$), terminology ($F = 5.60$, df = 1/68, $p. < .05$), comprehension ($F = 8.56$, df = 1/68, $p. < .01$), total criterion ($F = 7.83$, df = 1/68, $p. < .01$). All interactions occurred between mode of instruction (visual or nonvisual)

Table 3 About Here

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and order of drawing test (administered before or after students completed the individual criterion tests (Table 3). Follow-up analyses indicated that on the visual achievement tests (delayed retention) students who received the visualized instruction and completed the drawing test after completing the individual criterion tests achieved significantly higher mean scores. On immediate retention the interaction between mode of instruction and order of drawing test indicated that students who received the visualized instruction and completed the drawing test before completing the individual criterion tests achieved significantly higher mean scores. Figure 4 illustrates the obtained interaction on the different criterion measures.

Figure 4 About Here

Conclusions and Discussion

Based on the results of this study the following conclusions may be derived:

- Visual testing is significantly more effective than nonvisual testing in detecting main effects resulting from visualized instruction. For students receiving the visualized instruction, visual testing was found to be a highly sensitive evaluation strategy for assessing students' level of information acquisition of the type measured by the Identification, Terminology, Total Criterion (immediate and delayed retention) and the Comprehension Test (immediate retention). On the nonvisual test only one main effect (Identification, immediate retention) was detected.

- On the Drawing Criterion both the visual and nonvisual evaluation strategies detected significant main effects for mode of instruction and mode of Drawing Test; however, the visual testing mode also detected a significant main effect for order of Drawing Test.
- Only one interaction was detected on the immediate testing (Drawing Test) for the nonvisual testing strategy. No interactions were detected for the delayed retention.
- On the immediate testing no interactions were obtained via the visual testing format; however, on the delayed retention data obtained two weeks later significant interactions were obtained on the Identification, Terminology, Comprehension, and Total Criterion Tests.

The data obtained in this study clearly demonstrate the superiority of visual tests, when compared to nonvisual tests (of the type employed in this study), as a means of assessing the instructional effect of visualized instruction and their value as criteria for detecting main effects and interactions among instructional variables defined in terms of visual and nonvisual characteristics. It is also interesting to note that a very significant characteristic of visual testing was revealed in this study--its sensitivity in assessing delayed retention of visualized instruction in different cognitive levels (criterion test levels) and interactions among visual instructional variables that were not revealed on the immediate visual testing situation and were not detected in any way by the nonvisual test. These results would tend to question the appropriateness (Burr, 1963; Fargo, et al., 1967; Hopkins, et al., 1967; Stoker, et al., 1968; Dwyer & Tanner, 1978) of previous experimental studies that attempted to empirically investigate the effectiveness of visual tests and resulted in nonsignificant statistical differences or significant statistical differences favoring the nonvisual tests. In questioning previous results, the findings tend to confirm the contention that information retrieval is a very specific process, easily disrupted--and since features of the original learning cues are processed during a test, and reduction in the individual distinctiveness of the cues themselves would produce concomitant reductions in recall (Tulving, 1976; Jacoby & Craik, 1979; Battig, 1979).

The findings of this exploratory study are significant considering that (a) for most students it was their first opportunity to respond on visual tests--a rehearsal session where students would become acquainted with the type of test format they were to receive might have significantly improved their performance on the visual tests, and (b) the fact that the visual distractors for the visual test items were intentionally designed to be congruent with their verbal counterparts may have imposed a severe limitation on the true potential of the visual tests--if the visual tests were not hampered by this restriction, the investigators might have been able to design visual distractors which would have assessed more validly the students' level of information retention.

The fact that the visual testing strategy was significantly more effective in detecting main effects (or immediate and delayed retention) and interactions than was the verbal testing strategy indicates that in addition to more validly assessing student information acquisition, visual testing was instrumental in identifying some procedural considerations (interactions, e.g. mode of instruction X order of Drawing Test) in the teaching-learning process which may be capitalized upon to even further optimize the effect of visualized instruction and visual testing. The result of the study provides the justification for further inquiry and experimentation in the use of visualization in the evaluation mode of instruction--especially, where students receive visualization in the instructional mode.

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TABLE 1. Means, Standard Deviations, and Reliability Coefficients Obtained from the Nonvisual and Visual Test Formats on Each Criterion Measure for Immediate and Delayed Retention.

Variable	Identification Test		Terminology Test		Comprehension Test		Total Criterion Test		Drawing Test
	Immediate	Delayed	Immediate	Delayed	Immediate	Delayed	Immediate	Delayed	Cued Recall
Verbal (Nonvisual) Tests									
No. of Test Items	20	20	20	20	20	20	60	60	18
Mean Score	13.93	12.63	13.37	11.36	11.48	10.23	38.80	34.21	10.63
SD	4.52	4.49	4.31	4.42	3.69	3.73	11.28	11.13	4.64
Kuder-Richardson Formula 20 Reliability Coefficient	.86	.83	.82	.81	.72	.74	.92	.91	.89
Visual Tests									Free Recall
No. of Test Items	20	20	20	20	20	20	60	60	18
Mean Score	13.46	12.20	11.98	11.04	9.87	9.80	35.32	33.04	8.72
SD	4.21	4.46	3.67	3.70	3.99	3.99	10.66	10.73	5.13
Kuder-Richardson Formula 20 Reliability Coefficient	.82	.82	.74	.74	.76	.66	.91	.90	.92

Table 2. Means Representative of Main Effects on Each Criterion Measure
(Immediate and Delayed Retention)

Plate 1. Performance on Visual Test

Criterion Measure	Effect	Conditions		Results	F	P.<
Drawing	Instruction	Visual 12.7 (N=39)	Nonvisual 8.0 (N=37)	Mode of Instruction Favoring Visualized Instruction	16.54	.001
	Order of Drawing Test	Before 9.0 (N=38)	After 11.2 (N=38)	Order of Drawing Test Favoring Testing After Achievement Tests	5.42	.05
	Mode of Drawing Test	Verbal Cued 11.0 (N=38)	Free Recall 9.2 (N=38)	Mode of Drawing Test Favoring Verbal Cued	3.89	.05
Identification (Immediate)	Instruction	Visual 14.6 (N=39)	Nonvisual 12.2 (N=37)	Mode of Instruction Favoring Visualized Instruction	7.19	.01
Identification (Delayed)	Instruction	13.3 (N=39)	11.1 (N=37)	Mode of Instruction Favoring Visualized Instruction	4.41	.05
Terminology (Immediate)	Instruction	12.9 (N=39)	11.1 (N=37)	Mode of Instruction Favoring Visualized Instruction	5.26	.05
Terminology (Delayed)	Instruction	11.9 (N=39)	10.2 (N=37)	Mode of Instruction Favoring Visualized Instruction	4.76	.05
Comprehension (Immediate)	Instruction	10.9 (N=39)	8.7 (N=37)	Mode of Instruction Favoring Visualized Instruction	5.98	.05
Total Criterion (Immediate)	Instruction	38.4 (N=39)	32.0 (N=37)	Mode of Instruction Favoring Visualized Instruction	7.75	.01
Total Criterion (Delayed)	Instruction	35.5 (N=39)	30.5 (N=37)	Mode of Instruction Favoring Visualized Instruction	4.73	.05

Plate 2. Performance on the Nonvisual Test

Criterion Measure	Effect	Conditions		Result	F	P.<
Drawing	Instruction	Visual 11.2 (N=39)	Nonvisual 7.1 (N=36)	Mode of Instruction Favoring Visualized Instruction	17.32	.001
	Mode of Drawing Test	Verbal Cued 10.2 (N=37)	Free Recall 8.3 (N=38)	Mode of Drawing Test Favoring Verbal Cued	3.96	.05
Identification (Immediate)	Instruction	Visual 15.1 (N=39)	Nonvisual 12.7 (N=36)	Mode of Instruction Favoring Visualized Instruction	5.43	.05

Table 3. Interactions Obtained on the Different Criterion Tests

Plate 1. Performance on the Visual Achievement Tests (Delayed Testing)

Criterion Variable	Interactions	F-ratio	p. <	t-statistic	p. <
Identification	Mode of Instruction X Order of Drawing Test	5.18	.05	3.14	.05
Terminology	Mode of Instruction X Order of Drawing Test	5.60	.05	3.24	.05
Comprehension	Mode of Instruction X Order of Drawing Test	8.56	.01	3.16	.05
Total Criterion	Mode of Instruction X Order of Drawing Test	7.83	.01	3.57	.05

Plate 2. Performance on the Nonvisual Achievement Tests (Immediate Testing)

Criterion Variable	Interactions	F-ratio	p. <	t-statistic	p. <
Drawing	Mode of Instruction X Order of Drawing Test	6.31	.01	4.74	.05

Figure 1 · Free Recall and Cued Recall Versions of the Drawing Test

Plate A. Drawing Test - Free Recall

Name ______________________________ Date __________

1. Draw a picture of a heart in the space below.
2. List the names of the various parts in the numbered spaces at the bottom of this sheet.
3. Place the numbers of the identified parts where they would be located on the heart.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________
16. ____________________
17. ____________________
18. ____________________

Plate B. Drawing Test - Cued Recall

Name ______________________________ Date __________

Draw a picture of a heart and place the number of the identified parts where they would be located on the heart.

1. superior vena cava
2. aorta
3. tricuspid valve
4. pulmonary vein
5. septum
6. epicardium
7. aortic valve
8. pulmonary valve
9. inferior vena cava
10. pulmonary artery
11. myocardium
12. endocardium
13. mitral valve
14. right auricle
15. right ventricle
16. left auricle
17. left ventricle
18. apex

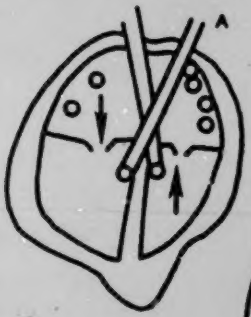
VERBAL TEST ITEM

When blood is being forced out the right ventricle, in what position is the tricuspid valve?

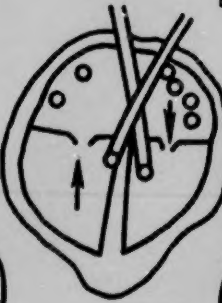
A.	partially opened	C.	open
B.	partially closed	D.	closed

VISUAL TEST ITEM

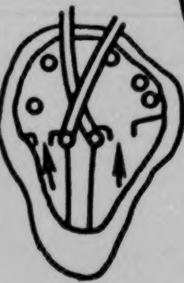
The position of the tricuspid valve when blood is forced out of the right ventricle



A



B



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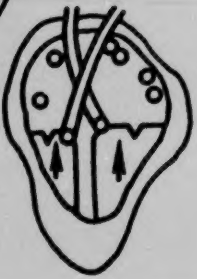

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FIGURE 2.

Verbal and Visual Forms of the Same Question on the Comprehension Criterion Test

Figure 3. Experimental design with distribution of subjects for each of the two evaluation strategies.

Plate #1: Visual Test Mode
(N=76)

MODE OF DRAWING TEST	MODE OF INSTRUCTION	ORDER OF DRAWING TEST	
		BEFORE	AFTER
VERBAL CUED RECALL	VISUAL	N=10	N=9
	NONVISUAL	N=10	N=9
FREE RECALL	VISUAL	N=10	N=10
	NONVISUAL	N=8	N=10

Plate #2: Nonvisual Test Mode
(N=75)

MODE OF DRAWING TEST	MODE OF INSTRUCTION	ORDER OF DRAWING TEST	
		BEFORE	AFTER
VERBAL CUED RECALL	VISUAL	N=10	N=9
	NONVISUAL	N=9	N=9
FREE RECALL	VISUAL	N=10	N=10
	NONVISUAL	N=9	N=9

Figure 4. Interactions on the Immediate and Delayed Testing (Visual and Nonvisual)

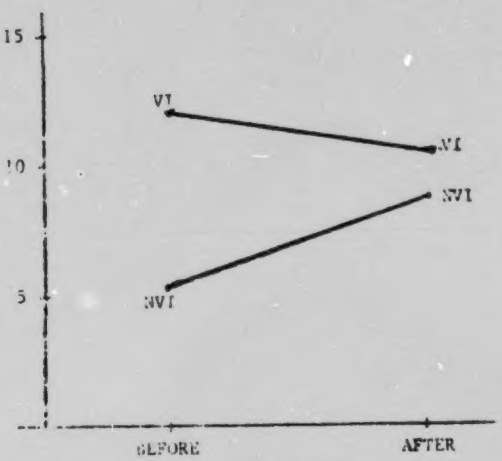

Plate 1. Interaction between mode of instruction and order of Drawing Test on the Drawing Test (immediate retention).

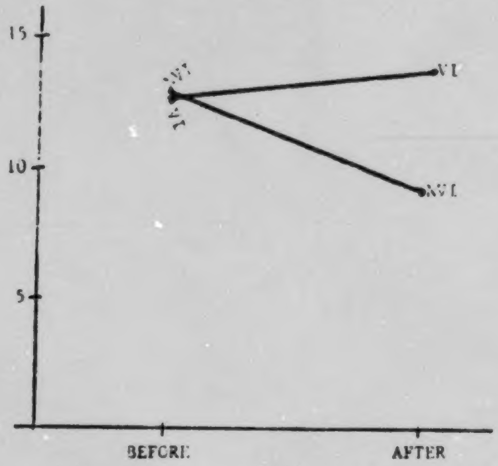

Plate 2. Interaction between mode of instruction and order of Drawing Test on the Identification Test (delayed retention).

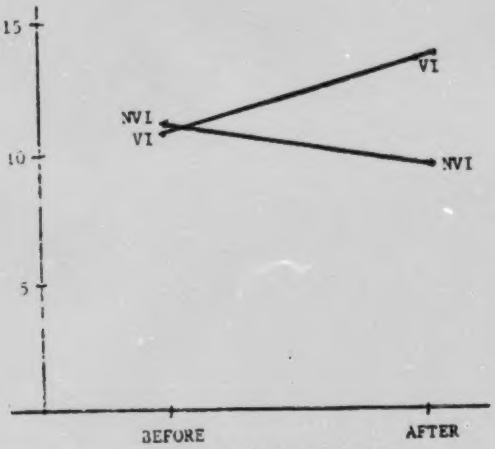

Plate 3. Interaction between mode of instruction and order of Drawing Test on the Terminology Test (delayed retention).

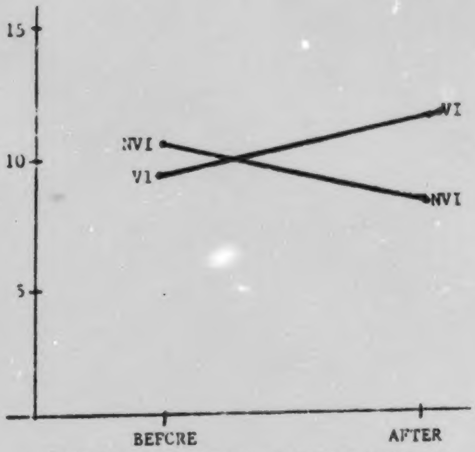

Plate 4. Interaction between mode of instruction and order of Drawing Test on the Comprehension Test (delayed retention).

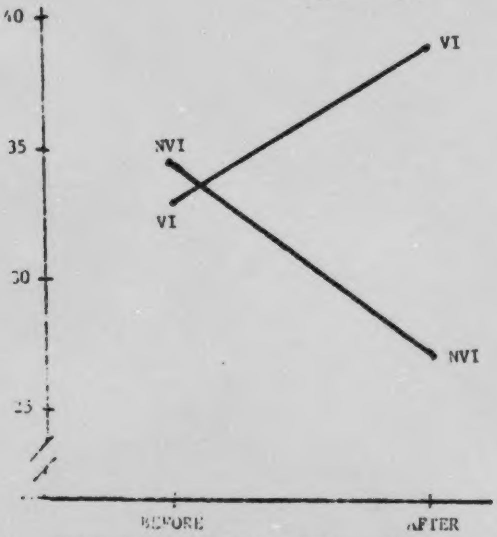

Plate 5. Interaction between mode of instruction and order of Drawing Test on the Total Criterion Test (delayed retention).

TITLE: A Multidimensional Analysis of the Instructional
Effectiveness of Visualized Instruction

AUTHORS: Francis M. Dwyer
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A MULTIDIMENSIONAL ANALYSIS OF THE INSTRUCTIONAL EFFECTIVENESS OF VISUALIZED INSTRUCTION

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A MULTIDIMENSIONAL ANALYSIS OF THE INSTRUCTIONAL EFFECTIVENESS OF VISUALIZED INSTRUCTION

Introduction

Conventional uses of visualized instructional materials (charts, slides, transparencies, visualized tests, workbooks, etc.) along with the newer more sophisticated electronic mediating systems (multi-media approaches to instruction, interactive microcomputers, telecommunications, satellite and educational television, teleconferencing, etc.) have become integral components of both traditional and nontraditional instructional strategies employed world-wide in an effort to improve the teaching-learning process at all levels. Within these varied instructional strategies the use of the visual medium has been optimized to assist learners in acquiring, storing, transmitting and applying information. However, the major criticism of this phenomenon is that, even though the visual medium is used to facilitate student information acquisition, most evaluation strategies used to assess the instructional impact of visualized instruction are of the pencil and paper type and are highly verbal rather than visual in nature (Hill, 1976; Dwyer, 1978). The essence of the problem is that we are teaching using one medium and evaluting in another. This condition exists even though the oldest and least controversial fact that can be derived from research on human learning is that any change in the retrieval (evaluation) environment from that which occurred in the original learning environment produces marked decrements in learner performance (Nitsch, 1977; Battig, 1979).

Implications derived from this position would indicate that in learning environments where visualization was used in the instructional (encoding) process and was not used in the retrieval (decoding) process, learner performance measures would yield gross underestimates, if not distortions, with respect to what and how much information had been originally acquired. This conceptualization suggests that information retrieval is a very specific process, easily disrupted--and since features of the original learning cues are processed during a test, any reduction in the individual distinctiveness of the cues themselves would produce concomitant reductions in recall (Tulving, 1976; Jacoby & Craik, 1979; Battig, 1979). Specifically, there is both theory and research which contends that the kind and quality of cognitive information processing that is facilitated by means of the use of mediated (visualized) instruction cannot be validly assessed via the use of verbal testing strategies.

Visual Testing

Researchers investigating the reliability, validity (Torrence, 1976) and administration (Hill, 1967) of visual tests have established that visual tests are indeed reliable, valid, and economical. Dwyer (1978), in reviewing the results of more than 650 articles related to visual learning and information processing, concluded that (a) the use of specifically designed visual materials in the teaching-learning process does facilitate increased student achievement, and (b) words and pictures are not processed in the same way nor are they equally effective in facilitating student achievement of different educational objectives (e.g., knowledge of terminology, identification, location, comprehension, etc.). A number of researchers (Paivio, 1971; Tulving, 1979; Fisher & Craik, 1977) have attributed the effectiveness of visualization in the learning process to the fact that visualized information can be processed simultaneously on several levels. They contend that this is possible because sensory-feature-processing precedes semantic analysis and that visual information processing need not unfold in lockstep fashion with antecedent features.

Problem Statement

Visualization is: (a) being used extensively in the teaching-learning process, (b) can be designed to facilitate increases in student achievement, (c) capable of being processed simultaneously on several cognitive levels, and (d) not being used in the testing or evaluation modes of information retrieval. Specifically, the purposes of this exploratory study were to empirically investigate (a) the effect of verbal instruction alone vs. verbal instruction complemented by simple line drawings, (b) the effect of visual testing vs. nonvisual testing of different educational objectives, (c) the effect of verbal cued vs. free recall on students' achievement, (d) the effect of order of testing on subsequent achievement and (e) the possible existence of interactions among modes of instruction, mode of testing, type of testing and order of testing.

Materials and Procedures

The content material used in this study was a 2,000-word instructional unit describing the human heart, its parts, and the internal processes that occur during the systolic and diastolic phases (Dwyer, 1967). This content was selected because it permitted evaluation of several types of learning objectives. The instructional content was developed to reduce and control, as much as possible, deficiencies identified in previous media research. For example, specific types of educational objectives to be achieved were identified; a specific content area that permitted meaningful learning to occur was selected;

three criterion tests measuring student achievement of different types of educational objectives were constructed; and visualization was systematically integrated into the verbal content material. In addition, student performance on the individual criterion tests was analyzed item by item to determine where students had difficulty. Thirty-seven such areas were identified. These difficulty areas were then traced back to the points in the instructional script where the information necessary to achieve on these items was originally presented. Once these difficulty areas had been identified, visuals were designed specifically to illustrate the information in each of the 37 critical areas. In this sense the visuals used to complement the verbal content in the instructional unit can be considered to be redundant. Students receiving the nonvisual mode of instruction interacted with the 2,000-word instructional unit in a self-paced booklet format which contained no illustrations. Students who interacted with the visualized mode of instruction received the same verbal content as did students who received the nonvisual mode; however, their self-instructional booklets were complemented by 37 visual illustrations. Figure 1 presents a sample frame from the nonvisual instructional booklet and the corresponding frame from the visualized instructional booklet.

Figure 1 About Here

Criterion Measures

Each student in each treatment participated in one of the instructional presentations and took three separate, 20-item criterion tests. Scores on the three individual criterion tests were combined into a 60-item total criterion test score. Students were permitted to take as much time as they needed to complete the instructional unit and the criterion tests. The following description of the kinds of performances measured by the criterion tests illustrates the kinds of educational objectives assessed in this study.

Drawing Test

This test had as its objective the evaluation of the subjects ability to construct and/or reproduce items in their appropriate context. For example, the test (N=18) items provided the students with a numbered list of items, e.g., (1) superior vena cava; (2) aorta; (3) tricuspid valve; (4) pulmonary vein; etc. corresponding to the parts of the heart presented in the instructional unit. The subjects were required to draw a representative diagram of the heart (a symbol like a valentine sufficed; the quality of the drawing did not enter into the scoring) and place the numbers of the listed parts in their respective positions. In this test, the emphasis was on the correct positioning of the verbal symbols with respect to one another and to their concrete references. The drawing tests used in this study existed in two versions: the verbal format (Figure 2, Plate B), because it listed the parts of the heart to be positioned was called the Verbal Cued Version. The Free Recall Version (Figure 2, Plate A), contained the same directions as the Verbal Cued Version but did not contain a listing of the parts of the heart to be positioned.

Figure 2 About Here

Identification Test

The objective of the identification test was to evaluate the students' ability to identify parts or positions of an object. This multiple-choice test required students to identify the numbered parts on a detailed drawing of the heart. Each part of the heart that had been discussed in the presentation was numbered on the drawing and appeared in a list on the answer sheet. The objective of this test was to measure the students' ability to use visual cues to discriminate one structure of the heart from another and to associate specific parts of the heart with their proper names.

Terminology Test

This test consisted of 20 multiple-choice items designed to measure knowledge of specific facts, terms, and definitions. The objectives measured by this type of test are appropriate to all content areas that have as a prerequisite to the more complicated types of learning a comprehensive understanding of the basic elements (terminology, facts, and definitions) indigenous to the discipline.

Comprehension Test

The comprehension test also consisted of 20 multiple-choice items. Students were given the location of certain parts of the heart at a particular moment of its functioning and asked to locate the position of other parts of the heart at the same point in time. This test required that students have a thorough understanding of the heart, its parts, its internal functioning, and the simultaneous processes occurring during the systolic and diastolic phases. The comprehension test was designed to measure a type of understanding that occurs when an individual understands what is being communicated and can use the information to explain some other phenomenon occurring simultaneously.

Total Criterion Test

The items contained in the three criterion tests were combined into a 60-item total criterion test. The purpose of this test was to measure the students' understanding of all the content material presented in the instructional unit.

The format of each of the 60 multiple choice items in the identification, terminology, and comprehension tests was a verbal stem with verbal response options. The visual version of this test was constructed so that for each of the 60 verbal items there was a matching visual item. For each of the response options on each of the 60 multiple-choice items an "equivalent" visual distractor was constructed. The stem of both the verbal and visual test questions were verbal and asked the same question; however, the stems of some of the visual test items were modified slightly to make them appropriate to the visual distractors. Figure 3 presents a sample of the verbal and visual formats for an item on the comprehension test.

Figure 3 About Here

Validity of the individual criterion measures is based on the congruence between the content information presented in the instructional units and the content measured by the test items. The verbal versions of the criterion tests have been used with more than 40,000 university and high school students and have been found to be effective in measuring information acquisition. Content validity of the visual format of the criterion tests was verified by a committee composed of four graduate students majoring in science education and a medical doctor. All considered the visual tests to be valid in content and appropriate to measure achievement resulting from content presented in the instructional units employed in this study.

Design and Analysis

One hundred fifty-one undergraduate students enrolled at The Pennsylvania State University were randomly assigned to one of sixteen treatment cells of the 2x2x2x2 posttest only experimental design. Figure 4 shows this design and number of students in each cell. The four independent variables were (a) mode of instruction: visual and nonvisual (See Figure 1), (b) mode of Achievement Test: visual and nonvisual (See Figure 3), (c) mode of Drawing Test: free recall and verbal cued recall (See Figure 2), and (d) order of Drawing Test: administered before or after completion of the three individual criterion measures. The dependent variables were (a) students' performance on the visual and nonvisual versions of the individual criterion tests--terminology, identification, and comprehension, (b) performance on the Total Criterion Test, and (c) on the Drawing Test. Students received the individual criterion tests immediately after receiving their respective instructional units and then again two weeks later to obtain a measure of delayed retention. ANOVA statistical designs were conducted on each criterion measure. Where significant F ratios (.05) were found, differences between pairs of means were analyzed via Tukey's W-Procedure.

Figure 4 About Here

Results

Table 1 presents the means, standard deviations, and reliability coefficients for students receiving the verbal and visual test formats for each criterion measure.

In comparing student performance on the main effect of instruction, students who received the visualized instruction achieved significantly higher scores on all criterion measures (verbal format only) than did students whose instruction did not contain visualization on both immediate and delayed retention respectively: Identification, $F(1, 135) = 12.33$, $p. < .01$; $F(1, 135) = 7.15$, $p. < .01$, Terminology, $F(1, 135) = 6.22$, $p. < .01$; $F(1, 135) = 5.47$, $p. < .05$, Comprehension, $F(1, 135) = 6.94$, $p. < .01$; $F(1, 135) = 3.97$, $p. < .05$, and Total Criterion, $F(1, 135) = 7.13$, $p. < .01$. These results strongly support the use of properly integrated visualization in the teaching-learning process. In comparing the performance of students who received the visual and verbal test formats insignificant differences were found to exist for the Identification Test; however, on the Terminology, $F(1, 135) = 4.79$, $p. < .05$, Comprehension, $F(1, 135) = 6.41$, $p. < .01$, and Total Criterion Tests, $F(1, 135) = 3.91$, $p. < .05$, significant differences were found to exist in mean achievement scores in favor of students who received the verbal versions of the criterion tests.

Table 1 About Here

In investigating the effect of when students received the Drawing Test, before or after completing the three individual criterion tests, the results indicated that students who received the Drawing Test after completing the individual criterion tests achieved significantly higher mean scores ($F(1, 135) = 5.60$, $p. < .05$). Also on the Drawing Test students who received the Verbal Cued version achieved significantly higehr scores than did students who received the Free Recall version, $F(1, 135) = 7.87$, $p. < .01$.

Significant interactions were found to exist: (a) among mode of instruction, mode of achievement and order of drawing test on the Identification Test, $F(1, 135) = 5.32$, $p. < .05$ (Figure 5, Plate 1), (b) between mode of instruction and mode of drawing test on the Terminology Test, $F(1, 135) = 4.22$, $p. < .05$ (Figure 5, Plate 2), (c) among mode of instruction, mode of achievement test and order of drawing test on the Drawing Test, $F(1, 135) = 4.05$, $p. < .05$, Figure 5, Plate 3, and (d) among mode of instruction, mode of achievement test and order of drawing test on the Delayed Total Criterion Test, $F(1, 135) = 7.19$, $p. < .01$, Figure 5, Plate 4.

Figure 5 About Here

Conclusions and Discussion

Based on the results of this study the following conclusions may be derived:

- The use of visuals (simple line drawings) to complement verbal instruction is an effective instructional strategy for facilitating student information acquisition of the type measured by the Identification, Terminology and Comprehension Tests--for both immediate and delayed retention.
- The use of visuals (simple line drawings) to complement verbal instruction facilitates the recall and subsequent reproduction (drawing) of the visuals presented in the instruction.
- Students who received the nonvisual test format (verbal) achieved significantly higher mean test scores on the Terminology, Comprehension, and Total Criterion Tests than did students who received the visualized version of the same tests. However, these effects disappeared on the two week delayed retention tests.
- The order of Drawing Test (before or after taking the three individual criterion tests) had no significant effect on students' performance on the individual achievement tests. However, students who received the Drawing Test after interacting with the individual achievement tests performed better on the Drawing Test than did students who received the Drawing Test prior to receiving the individual achievement tests.

- The mode of Drawing Test (verbal cued or free recall) had no significant effect on students' performance on the achievement test.
- Students who completed the verbal cued version of the Drawing Test performed better on the Drawing Test than did students who received the free recall version of the Drawing Test.
- Students who received the visualized instruction and interacted with the free recall version of the Drawing Test achieved significantly higher mean scores on the Terminology Test than did students who received the verbal instruction alone and received the free recall version of the Drawing Test.
- An interaction was obtained among mode of instruction, mode of achievement and order of Drawing Test (visualized instruction, non-visual test format, and Drawing Test administered before receiving the individual criterion tests) was obtained on the Identification Test.
- An interaction was found to exist among mode of instruction, mode of achievement test and order of Drawing Test (visualized instruction, visual tests and drawing test received after completion of the individual criterion tests) for both the Total Criterion Test (delayed retention) and for the Drawing Test.

The findings of this study indicate that the visualized version of the instructional unit significantly improved students information acquisition of the type measured by the criterion measures employed in this study--on both the immediate and delayed retention tests administered two weeks later. The visual testing mode was found to be more effective on the Comprehension and Total

Criterion Tests (immediate retention) and on the Identification Tests (delayed retention). This finding would tend to support the contention that although information acquisition may be facilitated by means of visualization it is converted from the visual to the verbal for storage and retrieval purposes. It is also possible that the visual approach to testing employed in this study was novel and since the students were unfamiliar with this type of testing they performed poorly. Interactions among mode of instruction and order of testing indicate that students' performance is influenced not only by how content is presented and evaluated, but also by the order in which specific cognitive learning levels are evaluated. These findings offer significant implications not only for those individuals involved in formal instructional development activities but also for those individuals who are concerned with improving the learning environment within the global teaching-learning process.

The general expectation that visual testing would be a more effective evaluation strategy than verbal testing in retrieving, from students, information acquired from visualized instruction was not realized. However, it is important to note that students who received the visualized instruction achieved significantly higher mean test scores on all criterion measures on both the immediate and delayed retention tests. It is possible that student performance on the visual tests was lower than might have been expected because for most of them this was their first exposure to visual testing and they were not quite sure how to respond. It might be that a rehearsal session where students would become acquainted with the type of test format they were to receive might have altered the results significantly; at least it would have put visual testing on a more equal basis with the conventional verbal multiple choice format. Secondly, the intentional design of the visual distractors in the visual test format (so that they were congruent with the verbal distractors of the verbal items) imposed a severe limitation; the investigators, had they not been restricted by an attempt to make congruent distractors, might have been able to design visual distractors that could have assessed more validly the students' level of information retention.

It is also possible that when visualization is used to complement verbal instruction and the visualization is designed to be redundant, it is simply providing an alternative iconic base from which students can interact and compound complex content material. This line of reasoning seems to coincide with the verbal-loop hypothesis (Glanzer & Clark, 1963a, 1963b, 1964), which contends that a stimulus (object or illustration) viewed by the learner is translated into a series of words which are held in memory until they are needed by the learner in making a covert or overt response.

The results of this preliminary research indicate that visual testing is at least equal to verbal testing in measuring student achievement of specific educational objectives. At this point it is important to recall that only one type of visual testing format (type of visual) was employed to assess student learning on all the criterion measures; whereas, different verbal multiple choice tests were used to measure student achievement of the different educational objectives. It may be that different visual testing formats are necessary if valid assessments of students' levels of achievement of different educational objectives are to be realized.

The fact that visualization has been found to facilitate students' learning of different educational objectives and that interactions were obtained among mode of instruction, mode of achievement test and order of test administration on several criterion tests indicates that there are some procedural considerations in the teaching-learning process which may be capitalized upon to even further optimize the effect of visualized instruction and visual testing.

One implication of our research is the need for further study of individual differences in information-processing ability and their relationship with acquisition of understanding. It can be hypothesized that students relatively unable to recreate instructional environments will perform better under visual content conditions. Interactions of visual placement with inductive reasoning ability have been noted by Koran and Koran (1976).

Holliday and associates (1977) have argued from a zero-sum standpoint that display of visuals in text may result in the reader's paying more attention to one cue and less to another, resulting in reduced effectiveness of visuals. This notion bears further investigation. If memory for visuals is greater than memory for text, the duration of that memory differential should be quantified by means of delayed retention tests. Time-on-task requirements of students receiving the different instruction and testing formats might also be considered as another dependent variable in future research.

Recent research suggests that training students to create mental images during instruction results in superior achievement (Canelos, 1979). Another question that might be investigated is the relative effectiveness of mentally induced visualization vs. visuals provided in instruction as a function of individual learner differences. A corollary question addresses the effectiveness of asking students to generate images for which there is no personal knowledge or experience (i.e., episodic memory).

The results of this experiment have suggested a new direction for visuals in instruction and additional ideas for further reasoned study.

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Figure 1.

FIGURE 1.
Sample Frames from the Nonvisual Instruction Booklet and the Visualized Instruction Booklet

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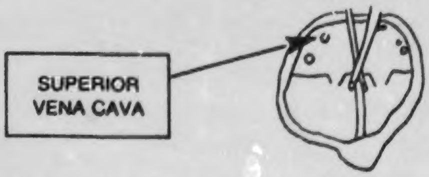
NONVISUAL INSTRUCTION BOOKLET

SUPERIOR
VENA CAVA

As you would view a cross-sectional diagram of the heart, blood enters the right auricle through veins. Only veins carry blood to the heart. The superior vena cava is one of the two veins which deposits blood in the right auricle. There are no valves at the openings of those veins into the right auricle. The superior vena cava drains blood into the right auricle from all body parts above heart level; i.e., head and arms.

VISUALIZED INSTRUCTION BOOKLET



As you would view a cross-sectional diagram of the heart, blood enters the right auricle through veins. Only veins carry blood to the heart. The superior vena cava is one of the two veins which deposits blood in the right auricle. There are no valves at the openings of these veins into the right auricle. The superior vena cava drains blood into the right auricle from all body parts above heart level; i.e., head and arms.

VERBAL TEST ITEM

When blood is being forced out the right ventricle, in what position is the tricuspid valve?

A. partially opened C. open
B. partially closed D. closed

VISUAL TEST ITEM

The position of the tricuspid valve when blood is forced out of the right ventricle

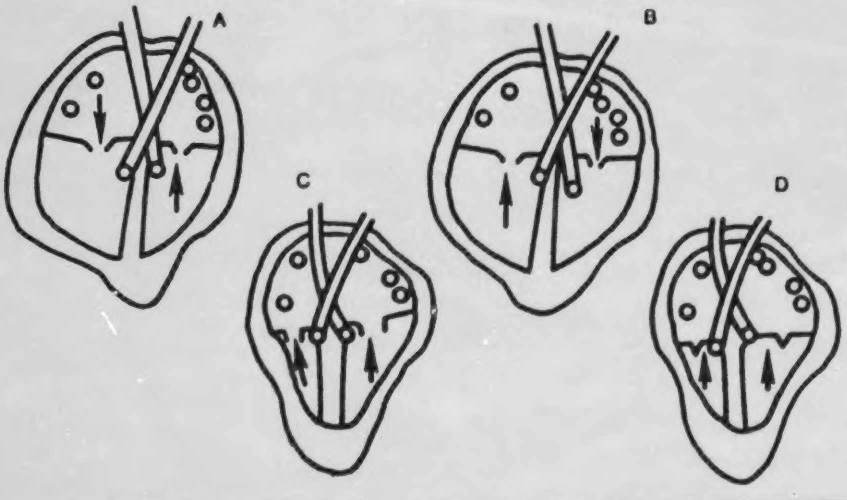


Figure 3.

FIGURE 3.
Verbal and Visual Forms of the Same Question on the Comprehension Criterion Test

Figure 2. Free Recall and Cued Recall Versions of the Drawing Test

Plate A. Drawing Test - Free Recall

Name ______________________________ Date __________

1. Draw a picture of a heart in the space below.
2. List the names of the various parts in the numbered spaces at the bottom of this sheet.
3. Place the numbers of the identified parts where they would be located on the heart.

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________
11. ____________________
12. ____________________
13. ____________________
14. ____________________
15. ____________________
16. ____________________
17. ____________________
18. ____________________

Plate B. Drawing Test - Cued Recall

Name ______________________________ Date __________

Draw a picture of a heart and place the number of the identified parts where they would be located on the heart.

1. superior vena cava
2. aorta
3. tricuspid valve
4. pulmonary vein
5. septum
6. epicardium
7. aortic valve
8. pulmonary valve
9. inferior vena cava
10. pulmonary artery
11. myocardium
12. endocardium
13. mitral valve
14. right auricle
15. right ventricle
16. left auricle
17. left ventricle
18. apex

		MODE OF ACHIEVEMENT TEST			
		VISUAL		NONVISUAL	
MODE OF DRAWING TEST	MODE OF INSTRUCTION	BEFORE	AFTER	BEFORE	AFTER
VERBAL CUED RECALL	VISUAL	N=10	N=9	N=10	N=9
	NONVISUAL	N=10	N=9	N=9	N=9
FREE RECALL	VISUAL	N=10	N=10	N=10	N=10
	NONVISUAL	N=8	N=10	N=9	N=9

ORDER OF DRAWING TEST

Figure 4. Experimental design with distribution of subjects by cell.

Figure 5. Interactions on the Immediate and Delayed Testing

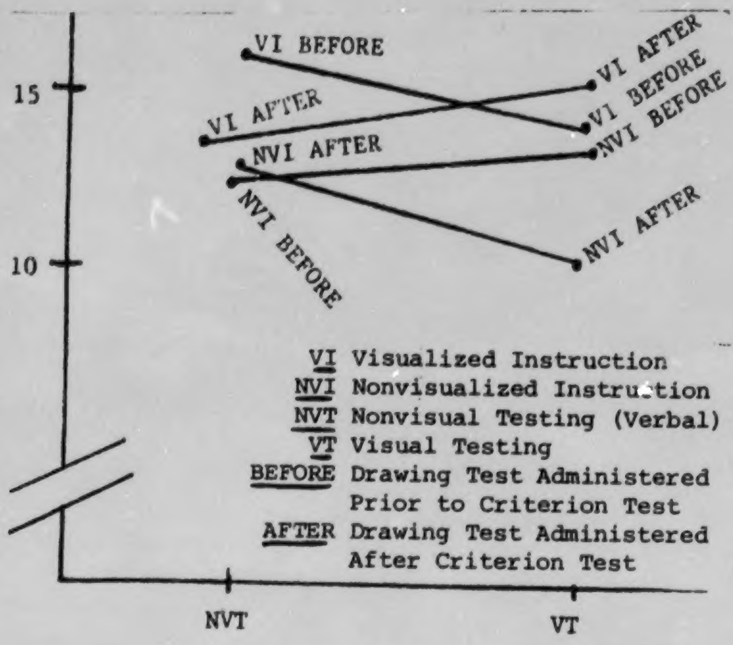


Plate 1. Interaction among mode of instruction, achievement test and order of Drawing Test on the Identification Test.

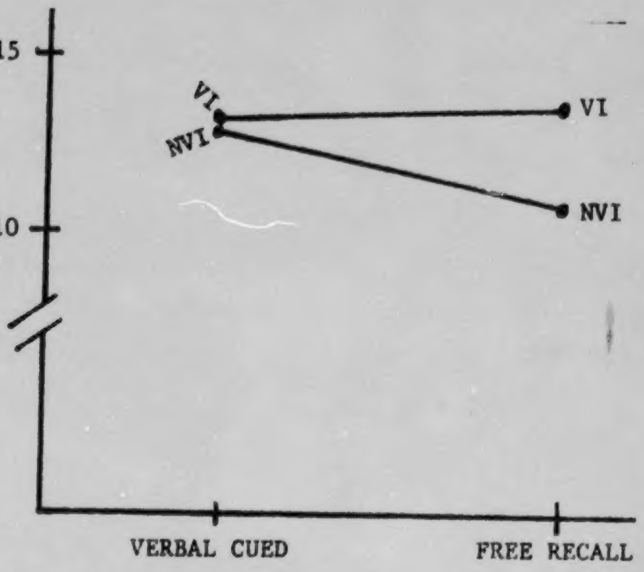


Plate 2. Interaction between mode of instruction and mode of Drawing Test on the Terminology Test.

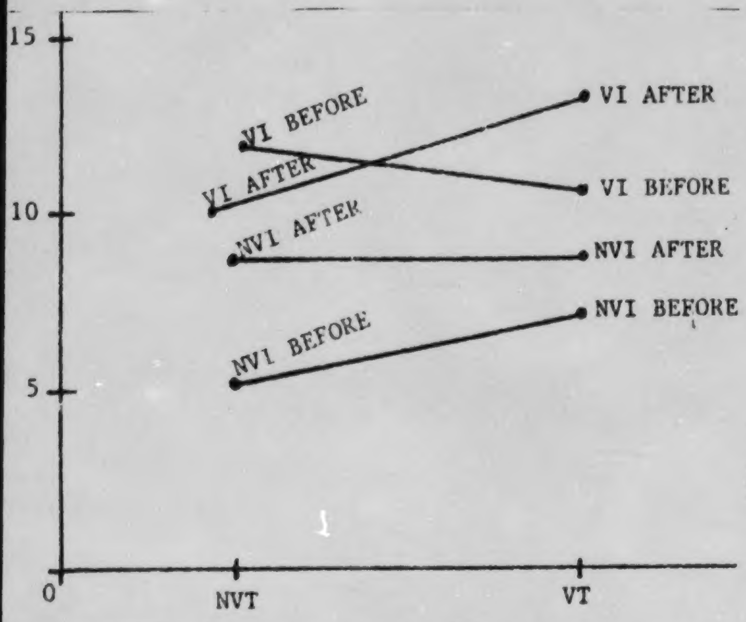


Plate 3. Interaction among mode of instruction, achievement test and order of Drawing Test on the Drawing Test.

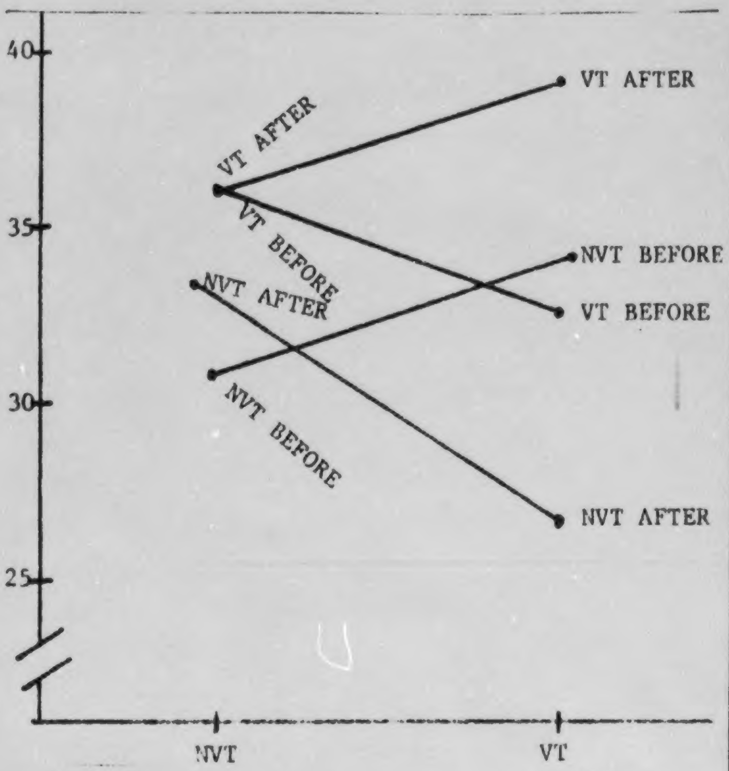


Plate 4. Interaction among mode of instruction, achievement test and order of Drawing Test on the Total Criterion Test (Delayed Retention).

TABLE 1. Means, Standard Deviations, and Reliability Coefficients Obtained from the Nonvisual and Visual Test Formats on Each Criterion Measure for Immediate and Delayed Retention.

Variable	Identification Test		Terminology Test		Comprehension Test		Total Criterion Test		Drawing Test
	Immediate	Delayed	Immediate	Delayed	Immediate	Delayed	Immediate	Delayed	Cued Recall
				Verbal (Nonvisual) Tests					
No. of Test Items	20	20	20	20	20	20	60	60	18
Mean Score	13.93	12.63	13.37	11.36	11.48	10.23	38.80	34.21	10.63
SD	4.52	4.49	4.31	4.42	3.69	3.73	11.28	11.13	4.64
Kuder-Richardson Formula 20 Reliability Coefficient	.86	.83	.82	.81	.72	.74	.92	.91	.89
				Visual Tests					Free Recall
No. of Test Items	20	20	20	20	20	20	60	60	18
Mean Score	13.46	12.20	11.98	11.04	9.87	9.80	35.32	33.04	8.72
SD	4.21	4.46	3.67	3.70	3.99	3.99	10.66	10.73	5.13
Kuder-Richardson Formula 20 Reliability Coefficient	.82	.82	.74	.74	.76	.66	.91	.90	.92

TITLE: Learning With Visuals Through Aptitude Sensitive Instruction

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Learning With Visuals Through Aptitude Sensitive Instruction

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Learning with Visuals through Aptitude Sensitive Instruction

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In many areas of training and technical education, convention demands the use of line-drawings to present conceptual information. Effectiveness of these materials may be limited due to learner differences not only in ability to discriminate a visual into component details, but also in strategies used to generalize specific information into concepts. The cognitive style field-dependence-independence has been related empirically to these differences (Witkin, Moore, Goodenough & Cox, 1977).

The aim of the present study was to investigate treatment variables which may interact to facilitate perception and learning of a concept. Effective task performance required the design of a functional media context from which relevant concept attributes could be easily discriminated and generalized.

In a typical concept-attainment task, learners are required to distinguish examples from non-examples of each concept class. To complete this task successfully a learner needs the aptitude capacity to discriminate and generalize the small visual details which characterize each concept example. Gagné (1977) has specified that discrimination and generalization skills are basic to all concept learning. He noted that the learner must first distinguish relevant details (discriminate), then further organize this information as a basis for classifying new items as examples or non-examples of a concept class (generalize). Previous research findings have indicated that concept attainment tasks are often more demanding for field-dependent individuals (Dickstein, 1968; Kirschenbaum, 1968; Witkin, Moore, Goodenough & Cox, 1977). Individuals who are perceptually field-dependent have been found to experience their world in a less differentiated fashion when dealing with perceptual/cognitive tasks (Witkin, Goodenough & Oltman, 1977; Witkin & Goodenough, 1977). The field dependent learner tends to rely on external referents which influence the strategies used in concept attainment tasks. That is, field-dependent persons tend to accept the visual field passively, as presented, and ignore important details which presumably are not salient to them. Furthermore, they appear to be dominated by the most salient or noticeable parts of a visual (Dickstein, 1968; Kirschenbaum, 1968). Hence, field-dependent individuals may be handicapped by unstructured materials in which relevant details are not made salient (Goodenough, 1976; Witkin, Moore, Goodenough & Cox, 1977). Their tendency to display less differentiated functioning is also evident in the processing strategies they use when directed to form concept hypotheses. Their hypothesis-testing strategy has been associated with a partist approach (Goodenough, 1976; Kirschenbaum, 1968). The field-dependent learner tends to form one concept hypothesis at a time based on the most noticeable or salient features of the concept example. If subsequent examples reveal that the hypothesis is not valid, then new features are chosen, and a new hypothesis is formed. If subsequent examples substantiate these features, then the hypothesis is retained (Goodenough, 1976). In other words, the field-dependent tends to note passively the dominant, salient cues, until it becomes obvious that certain features are associated with positive examples of the concept (Witkin, Moore, Goodenough & Cox, 1977).

This strategy may be contrasted with that of the field-dependent learners. These learners are capable of more differentiated functioning. That is, they are capable of using their restructuring skills as internal mediational processes (Witkin, Moore, Goodenough & Cox, 1977). Their hypothesis-testing strategies have been associated with a wholist approach (Goodenough, 1976; Kirschenbaum, 1968). The field-independent learner tends to scan the first positive concept example, and to retain *all* its attributes for later comparison with those in subsequent examples. If the hypothesis is proven to be inappropriate, then a revised hypothesis is formed. The wholist strategy of hypothesis testing is more active than the partist approach, and has resulted in better learning performance particularly when subjects were under time pressure (Bruner, Goodnow & Austin, 1956; Bourne, 1966). In his discussion of hypothesis-testing strategies, Mayer (1977) pointed out that the superiority of the wholist strategy could be due to its reduced demands on memory. The wholist has only to remember the attributes of the first example. Subsequent checks against examples reduce the memory requirement, as the wholist is able to eliminate those attributes which fail to reappear. Conversely, the memory demands for the partist strategy will increase with each wrong hypothesis. Subsequent new hypotheses will need to incorporate a record of all prior hypotheses that were disproven, to avoid using them twice. In summary, field-dependent learners may be handicapped by unstructured materials and lack of salient relevant details upon which to base their hypotheses (cf. Goodenough, 1976; Witkin, Moore, Goodenough & Cox, 1977). The difficulty of field-dependent learners may be particularly apparent when instructional time is limited by a fixed-pace presentation.

In a discussion of supplantation approaches, Salomon (1972) supported Cronbach & Snow (1969) by proposing that instructional materials should be developed "which for subjects to pay attention to and differentiate among details ... [and thus supplant or] compensate for the subject's deficient attentional and discrimination skills" (p.320).

Supplantation is based on the theory that learning will be most effective when the requirements of the learning task, and methods of presenting information either precisely complement the internal processing skills of the learner, or adapt to the aptitude of the student (cf. Ausburn & Ausburn, 1978). The present study sought to combine functional media attributes according to a supplantation model which aimed to increase the effectiveness of the visuals for all subjects. That is, the study aimed to use a compensatory supplantation approach to facilitate concept attainment for field-dependent learners by "short-circuiting" processing demands (cf. Salomon, 1979). The "short circuiting" method provides ready-made transformations which save the learner from having to perform the required processing operations. In Ausburn & Ausburn's terms (1977), this supplantation approach may utilize media as a "connecting link" which would otherwise be incomplete due to a learner's inability to meet certain task demands. Ausburn & Ausburn viewed this media link as a connection between learner and task that is facilitated through the use of supplantation techniques which form a bridging mechanism. Heidt (1977) has stressed that supplantation may vary not only in the nature of the process being supplanted, but also in the amount of supplantation provided. Hence, the present study did not take an all-or-none view of supplantation. Instead, it was assumed that the amount of supplantation may vary according to the nature of the learning task and capacity of the learner to meet task processing demands. It was also assumed that the structural attributes of media may vary according to learner aptitude and differing task demands.

An educational research model which seeks to integrate the demands of the learning task with the aptitudes of learners and approprite media characteristics has been termed "aptitude treatment interaction" (ATI) (cf. Cronbach & Snow, 1977). In their discussion of methods which may be utilized to design ATI research, Cronbach & Snow noted that a researcher might begin by specifying an aptitude of interest. They further suggested that once an aptitude has been fixed, the researcher should select experimental variables that seem to be related or matched to this aptitude. Task analysis was proposed as a first step in matching subject aptitude and treatment variables.

> Task analyses of aptitudes are essential .... Given an aptitude variable and some analysis of the processes it reflects, one than [sic] asks: What instructional techniques would make this competence especially relevant to learning? What would a treatment have to provide to make learning easy for the low-aptitude S? .... In constructing likely treatment variables, the implications of the aptitude construct and of previous validity studies on it need to be considered .... Once treatment elements are identified, a factorial design in which all these elements can be varied independently is an option (Cronbach & Snow, 1977, p.172).

These views of Cronbach & Snow (1977) were incorporated in the design of the present study. The aptitude, field-dependence-independence has undergone extensive validation study (Witkin, Oltman, Raskin & Karp, 1971). On the basis of the processes reflected by this cognitive style, a concept attainment task was selected. This task was designed to be style eliciting. That is, it sought to elicit strategies and effects related to both field-dependent and field-independent capacities for functioning. The present study also incorporated the use of several structural media attributes which varied both in the nature and the amount of supplantation provided. These structural attributes represent the three independent treatment variables which were selected according to the hypothesized functions they may perform for learners differing in aptitude. The three treatment variables were:

(a) colour versus non-colour type of cueing;

(b) simple versus complex degree of informative detail;

(c) inductive versus deductive type of verbal presentation.

These treatments sought to combine media variables in an attempt to find an effective means of increasing the salience, or noticeability of relevant concept attributes.

The first treatment variable of interest was that of the use of colour-cueing of relevant visual details. In colour-cued treatments, the relevant features (attributes) of each concept class were coloured in red. Both Hull (1920) and Trabasso (1963) have used red to emphasize relevant attributes as an effective aid to concept-attainment. On the basis of discussions (e.g. Allen, 1975; Chute, 1979; Garrick, 1978) relating to the potential functions of colour in instructional variable, several considerations led to the inclusion of colour-cueing. These included the hypothesized ability of colour:

(a) to direct attention to relevant details by making cues more salient and by delineating figure-ground relationships;

(b) to isolate details while maintaining context relationships as an aid in making discriminations.

(c) to provide organizational aids by showing interrelatedness.

It was hypothesized that these functions may facilitate concept attainment by increasing the salience of relevant concept attributes. However, colour appears to be a "fragile cue ... apt to be superceded by more potent cues" (Otto & Askov, 1968, p.163). Both Otto & Askov and Chute (1979) have suggested that instructional materials should not have colour as the only cue available to facilitate processing especially in complex tasks that are high in stimulus similarity. This should not be interpreted to suggest that colour is an ineffective cue. When used to perform an integral function (cf. Chute, 1979), colour can be more effective, especially when the relevant concept attribute is embedded (Trabasso, 1963). Both Chute (1979) & Lamberski & Roberts (1979) have suggested that the value of colour may lie in its possible interrelated role.

Trabasso (1963) revealed that the effect of colour emphasizers may be reduced by counter-emphasizers; that is, irrelevant information which was not held constant, appeared to compete for the subject's attention by directing the learner away from relevant details. Many relevant-cue theorists (e.g., Canelos, 1979; Dwyer, 1972) propose that in some learning tasks, complexity should be edited or simplified in order to avoid processing interference caused by too many relevant cues. To test these views, the present study included both simple line-drawing and complex line-drawing treatments as a second independent, treatment variable. This variable was termed degree of informative detail, in order to reinforce that degree of abstraction/realism was not used to differentiate simple from complex line-drawings.

In complex treatments, the line-drawings were high in informative detail; that is, they showed a high degree of interior (figure) and ground detail that was not related to the concept. Simple line-drawings were lower in degree of informative detail; that is, they showed mainly relevant interior (figure) detail and as little irrelevant detail as possible. Several functional considerations led to the inclusion of simple degree of informative detail in the study. These included the hypothesized ability of simple line-drawings:

(a) to isolate details while maintaining context relationships (c f. Heidt, 1977);

(b) to reduce the counter-emphasizer effect of irrelevant stimuli (cf. Trabasso, 1963);

(c) to decrease abstraction time and learner effort (cf. Canelos, 1979; Fleming & Sheikhian, 1972; and Joseph, 1979);

(d) to facilitate objectives requiring the comprehension and explanation of concepts (cf. Arnold & Dwyer, 1975).

In cue-summation theory, Severin (1967) raised the question of the possible summation of cues between auditory and visual channels. The present study was also concerned with the possible summation of an emphasizer effect by presenting information through more than one sense modality. Hence, the third treatment variable related to the auditory mode. This variable was termed inductive versus deductive mode of verbal presentation.

Both inductive and deductive treatments were presented via an audiotape which accompanied the line-drawings. Deductive presentations utilized a specific verbal description of the features of each concept type. The deductive presentation was made immediately before the visual presentation of examples and non-examples. This mode of presentation may be contrasted with the inductive mode which did not provide a verbal description of each concept type. Instead, the inductive presentation urged the subjects to search for the defining attributes of each concept type. The provision of a concept definition in addition to a set of teaching examples has been found to be significantly more facilitative than a set of teaching examples alone (Feldman, 1972). Pishkin (1965) has suggested that specification of concept attributes may reduce learning difficulty by reducing the number of hypotheses to be considered. Ausubel & Robinson (1969) have suggested that for learners to learn effectively, they should be presented with background information as a basis for understanding new facts. This "advance organizer" approach may closely parallel the deductive presentation used in the present study. Several studies have supported the use of descriptions which provide verbal cues to concept definition (e.g., Frayer, 1970; Frederick, 1972; Pishkin, 1965). Based on the preceding research findings, several functional considerations led to the inclusion of deductive mode of presentation in the present study. These included the hypothesized ability of deductive presentations:

(a) to direct attention to relevant details through the use of verbal cues and by increasing redundancy of critical information;

(b) to provide organizational aids through advance verbal description of relevant details.

METHODOLOGY

A subject sample of 492 males aged 16-21 years, was drawn from a College of Technical and Further Education in Melbourne, Australia. All subjects were trade apprentices predominantly from the automotive department. Aptitude groups were designated on the basis of performance on the Group Embedded Figures Test (Witkin, Oltman, Raskin & Karp, 1971). Field-independent subjects were determined to represent the upper 27 1/2% of highest scoring subjects. Field-dependent subjects were determined to represent the lower 27 1/2% of lowest scoring subjects (cf. Feldt, 1961). The instructional materials consisted of a series of line-drawings which were copied onto filmstrip with an accompanying audiotape. The topic "Fuel Injector Nozzles in Diesel Engines" was chosen as a suitable concept-attainment task. Five types of injectors were selected to represent five different concept classes. Most of the injectors had global similarities, yet, each concept class had specific differences which allowed for the classification of each example into one of the five concept groups. Subjects were pretested for existing knowledge, and then randomly assigned to an individual sound/filmstrip machine which was loaded with one of the treatment combinations. Each treatment was externally-paced. The three treatment variable combined to form eight treatments, each of which contained either colour or non-colour cueing, plus either simple or complex line-drawings accompanied by either an inductive or deductive verbal presentation. By administering these eight treatment combinations to blocks of either extreme field-dependent or extreme field-independent subjects, a total of sixteen treatment groups was formed. Thus, a 2x2x2x2 factorial, extreme-groups design was used to implement this study. For the discussion which follows the results of two immediate posttest measures will be outlined and compared.

1. a definition test. Subjects were asked to provide definition (using words and/or pictures) of what each of the five concept types had "looked like". The test was administered immediately following the instructional sequence for each concept type. An objective rating scale, based on concept analysis, was developed to facilitate the scoring of the definitions.

The ability to provide an accurate definition of a concept appears to relate to the formal level of Klausmeier, Ghatala & Frayer's model of conceptual learning (1974). At this level the learner can identify examples and non-examples of the concept, and most importantly can name the concept and accurately identify it in terms of all its relevant attributes.

2. An identification test (referred to as the line-drawings test). Following the completion of all instructional sequences, the subjects were presented with a series of line-drawings for identification.

The ability to identify different examples as belonging to the same concept class appears to relate to the classificatory level of Klausmeier, Ghatala & Frayer's model of conceptual learning (1974). At the classificatory level, the learner not only can discriminate and recognize concept attributes, but also can generalize to other examples on the basis of specific, common attributes. It is important to note that learners who performed well on the line-drawing test may have also reached the formal level of attainment.

DATA ANALYSIS

It should be noted that there was some subject mortality after subject allocation to treatments resulting in unequal n's in the treatment of groups. These subject losses were caused by equipment breakdown and administrative procedures. Mortality was not related to the experimental treatments. Analyses of designs with unequal sample sizes may warrant consideration of the possible violation of the homogeneity of variance assumption (Keppel, 1982; Kirk, 1968). Hence, in the present study, this assumption was tested using the Hartley Test using procedures given by Kirk, 1968. Results indicated that the homogeneity assumption was not violated (see Table 1). This permitted the use of standard F tables in the analysis of data from this study.

A four-way analysis of variance was used to investigate main effects and interactions among the four factors; that is, the three treatment variables and the subject aptitude variable. Where a significant three-way interaction occurred, post hoc analyses were conducted to test for simple main effects. These tests used procedures and formulas given by Keppel, 1973; Kirk, 1968 . Simple effects "refer to the detailed or specific effects of an independent variable; these effects are revealed by examining the treatment means within the body of the matrix row by row or column by column" (Keppel, 1982, p.176).

The Pretest

Analyses of scores for the pretest of prior knowledge revealed that there was no significant difference between the pretest scores of the field-independent and field-dependent groups, t (247) = 1.08, $p > .1$.

The Definition Test

Analyses of variance revealed two statistically significant main effects. No significant interactions were found beyond the .05 level (see Table 2).

The analyses plus inspection of relevant treatment means revealed that:

(a) Field-independent subjects scored significantly higher than field-dependent subjects, F (1,233) = 22.33, $p < .001$.

(b) Subjects in the deductive treatments scored significantly higher than subjects in the inductive treatments, F (1,233) = 42.65, $p < .0001$.

All treatment group means and standard deviations for the definition posttest have been presented in Tables 3 and 4.

The Line-Drawings Test

Analysis of variance revealed statistically significant findings for the line-drawings test. As interactions were found, the main effects of the factors involved in the interaction must be interpreted with caution (cf. Keppel, 1982). The analysis of variance and inspection of treatment means _suggested_ the following main effects: (a) Degree of informative detail--students in simple line-drawing treatments scored significantly higher than students in complex line-drawing treatments, F (1,229) = 10.45, $p < .01$. (b) Mode of verbal presentation--the deductive-treatments resulted in significantly higher scores than the inductive treatments, F (1,229) = 11.95, $p < .001$. (c) Subject aptitude--field-independent subjects scored significantly higher than field-dependent subjects on the line-drawing (identification) test, F (1,229) = 60.36, $p < .0001$.

The analysis of line-drawing scores also revealed two statistically significant interactions. Simple/complex treatment (degree of informative detail) interacted with field-dependence-independence (subject aptitude),

F (1,229) = 6.31, $p < .05$. The colour/non-colour cueing by simple/complex drawings by inductive/deductive treatments interaction; (that is, type of colour cueing x degree of informative detail x mode of verbal presentation) also was significant, F (1,229) = 5.30 $p < .05$. Table 5 provides a summary of the analysis of variance.

The presence of significant interactions in the analysis of variance renders the main effects uninterpretable without further analyses of the nature of the interactions. These tests were conducted and led to the following results. Figure 1 graphically presents the means of the significant three-way interaction. It is important to note that the influence of colour/non-colour cueing appears to be significant in this higher-order interaction. This led to a test of the simple interaction effect of the simple/complex variable with the inductive/deductive variable for each of the colour and non-colour treatment groups. The results of these F tests indicate that the interaction effects were not significant in colour-cued treatments, but were significant in non-colour-cued treatments, F (1,229) = 4.87, $p < .05$. A summary of the results of the tests of simple interaction effects may be found in Table 6.

Subsequent analyses of simple, simple main effects of the three-way interaction revealed that there was no significant difference between deductively presented, simple, non-colour-cued treatments and inductively presented, simple, non-colour-cued treatments. However, deductively presented, complex, non-colour-cued treatments scored significantly higher than inductively presented, complex, non-colour treatments; F (1,229) = 10.84, $p < .001$. See Figure 1 (right panel) and Table 7. This pattern of results was not evidenced in colour-cued treatments. Analyses of simple, simple main effects revealed that in treatments that were colour-cued, there was no significant differences between deductively presented, complex treatments and inductively presented, complex treatments. However, deductively presented, simple, colour-cued treatments were superior to inductively presented, simple, colour-cued treatments; F (1,229) = 6.95, $p < .01$. See Figure 1 (left panel) and Table 7.

A second set of simple, simple main effects focused on simple/complex degree of informative detail. These analyses revealed that simple, inductive, non-colour treatments scored higher than complex, inductive, non-colour treatments; F (1,229) = 9.76 $p < .01$. There was no significant difference between simple, deductive, non-colour treatments and complex, deductive, non-colour treatments. See Figure 1 (right panel) and Table 7. This pattern of results was not evidenced in colour-cued treatments. Analyses revealed that in treatments that were colour-cued, there was a significant difference between simple, deductive treatments and complex deductive treatments; F (1,229) = 4.09, $p < .05$. However, there was no significant difference between simple, inductive, colour-cued treatments and complex, inductive, colour-cued treatments. See Figure 1 (left panel) and Table 7.

Figure 2 graphically illustrates the cell means of the significant two-way interaction and shows the score differences between field-dependent and field-independent subjects in both simple and complex line-drawing treatments. To support this visual inspection, the scores were tested for simple main effects. The results of these F tests revealed that field-independent subjects in simple line-drawing treatments scored significantly higher than field-independent subjects in complex line-drawing treatments; F (1,229) = 17.45, $p < .001$. See Table 8. The analyses for the field-dependent subjects was not significant at the .05 level. Inspection of Figure 2 also reveals that field-independent subjects' performance was superior to field-dependent subjects' performance. The superiority for field-independent scores was found to be significant for both simple treatments; F (1,229) = 54.50, $p < .001$ and complex treatments; F (1,229) = 13.90, $p < .001$.

All treatment group means and standard deviations for the line-drawings posttest have been presented in Tables 9 and 10.

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DISCUSSION

Results from both immediate measures confirmed that learners with field-dependent aptitude have difficulty with externally-paced, concept attainment tasks which require ability to discriminate and generalize. It was not the intent of this paper to depict the field-independent subject as a "better" learner. Nevertheless, it is likely that performance on many concept attainment tasks may be facilitated by a more differentiated, field- independent strategy. Concept learning may be hampered by an extreme field-dependent orientation particularly when relevant cues are not salient and not clearly organized, and when instructional time is limited by fixed-pace presentations.

On the line-drawings posttest field-independent subjects' performance was most facilitated through the use of simple line-drawings as opposed to complex line-drawings. However, field-dependent subjects' performance did not appear to be similarly influenced by degree of informative detail. This finding is in agreement with that of Frederick (1968) who found that only more analytic learners were sensitive to amounts of relevant versus irrelevant information. As was also apparent in the line-drawings posttest, Frederick's less analytic subjects' performance was unaffected by changes in the degree of irrelevant information, whilst more analytic subjects' performance was affected by these changes. Presumably, field-independent individuals may have the aptitude to process visuals that have a high degree of irrelevant information (cf. Koran, Snow & McDonald, 1971). Yet, it is possible, that simple line drawings decreased abstraction time and processing effort which permitted more efficient and effective processing by field-independent subjects. Conversely, field-dependent individuals may have greater difficulty in isolating relevant information in materials with high degree of irrelevant information (cf. Koran, Snow & McDonald, 1971).

Yet, it is possible, that simple line-drawings did not provide adequate supplantation to overcome their processing difficulties which were evident in the line-drawing posttest. Perhaps, field-dependent learners needed a more powerful, cue-summation effect of combining selected functional attributes to supplant their processing weaknesses? In this light, findings from the line-drawings posttest warrant consideration. While simple line-drawings facilitated performance in general, for all learners, the three-way interaction of all treatment variables suggested that specific treatment combinations may provide effective compensatory supplantation for field-dependent learners. Furthermore, these treatment combinations may also function to activate the appropriate processing modes of field-independent learners.

In general, there was no significant difference between colour-cued and non-colour-cued materials. However, analyses of the three-way interaction of treatment variables revealed that the pattern of results in colour-cued treatments differed to the pattern of results in non-colour-cued treatment. This confirmed the potential impact of type of colour-cueing as an interactive variable. The implication of this finding may be significant in the design and prescription of instructional materials. That is, when visuals were colour-cued, simple visuals presented deductively were superior to simple/inductive, complex/deductive, and by inference to, complex/inductive treatments (see Figure 1). However, when visuals were non-colour-cued, performance was impeded by complex visuals presented inductively. These findings suggest that: (a) complex/inductive treatments were inappropriate for concept-attainment tasks utilizing an identification measure typified by the line-drawings task; (b) simple/deductive treatments were appropriate for concept-attainment tasks utilizing an identification measure typified by the line-drawings task; and (c) the appropriate selection of either simple/inductive or complex/deductive treatments may be dependent upon the presence or absence of colour-cueing. When visuals were colour-cued, simple/inductive and complex/deductive treatments appeared to be less successful than simple/deductive treatments. Conversely, when visuals were non-colour-cued, simple/inductive and complex/deductive treatments were as successful as simple/deductive treatments. These relative differences in treatment effectiveness may be related to differences in processing ease which may have been accentuated by the limited time available in this externally-paced task. In some cases, the addition of colour may increase processing demands and time (cf. Lamberski & Roberts, 1979). The inclusion of complex and/or inductive treatments may have added to these processing demands in colour-cued treatments, resulting in poorer performance. Conversely, the combination of simple/deductive/colour may have reduced processing and time demands, by producing a cue-summation effect which functioned to isolate, emphasize and organize relevant information. For example, the deductive presentations may have clarified the significance of the colour-cueing, as opposed to inductive modes which gave no processing clues as to the meaning of the colour cues. The simplified visuals may have further reduced processing and time demands by aiding colour cues to isolate and direct attention to relevant concept details. When visuals were non-colour-cued, only the complex-inductive treatment resulted in significantly lower performance. This result may be also attributed to an increase in processing demands and time associated with this treatment. The other treatments provided either simple visuals to isolate and emphasize relevant cues, or deductive presentations to emphasize and organize relevant details. The non-colour, complex, inductive treatment did not provide any of these processing aids. Processing demands and time, and associated processing difficulty appear to have increased as a consequence, resulting in poorer performance.

The general superiority for a deductive mode of presentation (definition posttest) is in keeping with findings reported by Klausmeier, Ghatala & Frayer (1974), Remstad (1969), and Swanson (1972), who have supported the rate of verbal emphasizers as facilitating performance on a concept attainment task. As Klausmeier et al. pointed out, definitions may make relevant cues more noticeable and, as a result, may aid in the differentiation of relevant from irrelevant information. This may increase both learning efficiency and effectiveness by reducing the number of possible hypotheses (Pishkin, 1965), which may be helpful in reducing the memory demands which have been associated with field-dependent hypothesis-testing strategies (cf. Mayer, 1977). By providing ready-made transformations, the deductive presentations may have facilitated both field-dependent and field-independent processing by providing advance organizers which presented a format to guide the organization and restructuring of the visual information which followed (cf. Ausubel & Robinson, 1969; Lewis, 1980). The facilitative effect of advance preparation of learners has been documented previously by several sources (e.g., Allen, 1975; and Gagné & Rohwer, 1969). In the definition posttest, mode of verbal presentation represented an important consideration which influenced performance on a concept task requiring that subjects provide an accurate description of the concept. As deductive presentations provided a complete verbal description of all concept attributes, it is not surprizing that these presentations were found to result in superior performance on the definition posttest.

Cronbach & Snow (1977) have suggested that the design of instruction should be selective according to aptitude. Their emphasis is directed towards the choice of appropriate instructional techniques, rather than to the selection of a medium as an invariant entity. This view is particularly appropriate when considering the implications for instructional practice suggested by this study. First, the results suggest practical implications in terms of specific processes reflected by field-dependent and field-independent learners when dealing with line-drawings. The findings complement these implications by supporting the view that the design of instruction should be selective because of cognitive style differences in processing information in a concept attainment task. Although the same treatments often facilitated both field-dependent/field-independent performance, one important implication should not be overlooked. While the effective treatments permitted field-independent indivudals to perform *more* successfully, for the field-dependent learners, these same treatments may have been of critical importance in reaching a criterion of success. As expected, field-dependent individuals appeared to be handicapped in reaching higher levels of concept attainment. The effective treatments may have been imperative for acceptable performance by field-dependent learners who may have needed specific supplantation in order to meet a basic performance criterion. Pedagogical procedures need to acknowledge the potential relationship between the processing capacity of a learner and the processing demands for information to be acquired. Consequently, instructional designers/educators should *tailor* materials to *fit* both the cognitive, psychological requirements of the task and the cognitive style predispositions of learners. In so doing, they will promote a regard for the individual that is made possible through aptitude sensitive instruction.

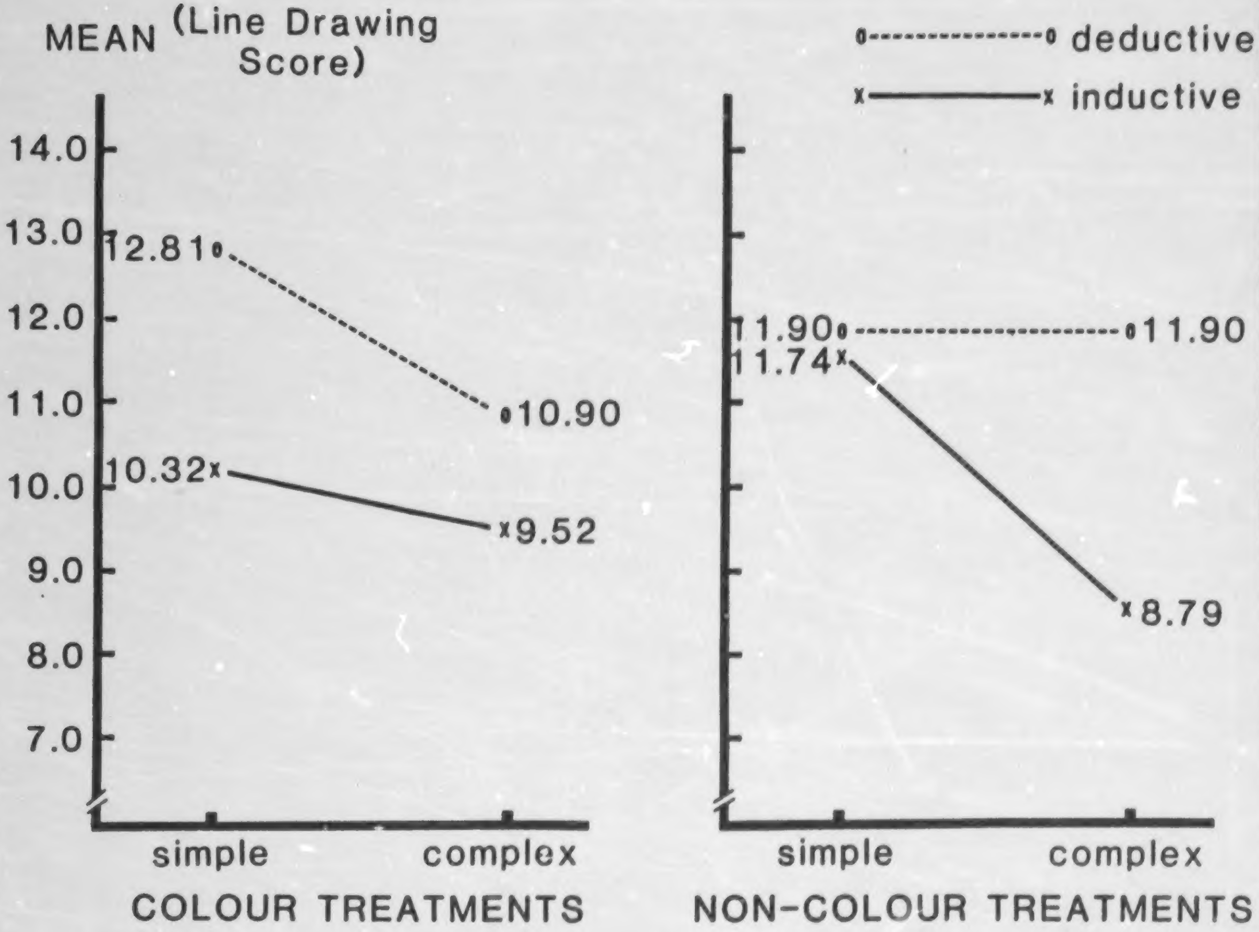

Figure 1 : Graph of treatment means of the significant three-way interaction (colour/non-colour X simple/complex X inductive/deductive treatments)--line-drawing posttest

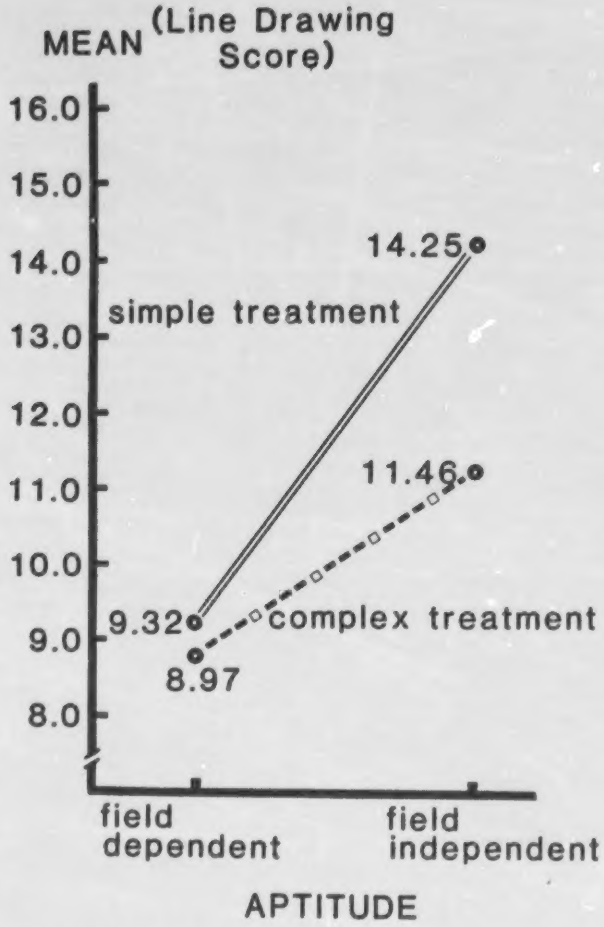

Figure 2 : Graph of treatment means of the significant two-way interaction (simple/complex treatment X field-dependent/field-independent aptitude) --line-drawing posttest

Table 1

Results of Hartley's Test of Homogeneity of Variance for all Posttest Scores (Study I) (Kirk, 1968, p.62)

Posttest	Largest Variance	Smallest Variance	df	*F* max.
Line Drawings	23.98	7.27	16,13	3.30*
Definitions	63.93	11.46	16,16	5.58*

* $p > .05$

Table 2

Analysis of Variance of Scores on Definition Test Items (Study I)

Source of Variance	SS	df	MS	*F*
A Colour/Non Colour Treatments	76.205	1	76.205	2.40
B Simple/Complex Treatments	112.528	1	112.528	3.50
C Inductive/Deductive Treatments	1352.196	1	1352.196	42.65**
D Field-Dependent-Independent Aptitude	707.875	1	707.875	22.33*
AxB	4.255	1	4.255	0.13
AxC	98.764	1	98.764	3.12
AxD	61.446	1	61.446	1.94
BxC	34.853	1	34.853	1.10
BxD	4.606	1	4.606	0.15
CxD	53.609	1	53.609	1.69
AxBxC	37.480	1	37.480	1.18
AxBxD	22.833	1	22.833	0.72
AxCxD	20.930	1	20.930	0.66
BxCxD	49.175	1	49.175	1.55
AxBxCxD	45.608	1	45.608	1.44
Explained	2720.107	15	181.340	5.72
Residual	7386.769	233	31.703	
TOTAL	10106.876	248	40.754	

* $p < .001$

** $p < .0001$

Table 3

Treatment Group Means & Standard Deviations for Field-Dependent and Field-Independent Aptitude (Definition Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent					
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n
1. Simple,Inductive,Non-Colour	20.00	(5.82)	19	23.87	(3.74)	15	21.71	(5.31)	34
2. Simple,Inductive,Colour	16.80	(3.38)	15	20.43	(5.54)	14	18.55	(4.84)	29
3. Complex,Inductive,Non-Colour	16.76	(5.58)	17	21.06	(8.00)	17	18.91	(7.13)	34
4. Complex,Inductive,Colour	18.53	(5.77)	15	16.81	(6.04)	16	17.65	(5.87)	31
5. Simple,Deductive,Non-Colour	21.64	(7.70)	14	26.12	(6.42)	17	24.09	(7.27)	31
6. Simple,Deductive,Colour	23.00	(5.69)	16	26.13	(5.18)	15	24.52	(5.59)	31
7. Complex,Deductive,Non-Colour	21.29	(4.41)	14	26.40	(3.87)	15	23.93	(4.83)	29
8. Complex,Deductive,Colour	21.07	(4.96)	15	25.93	(5.26)	15	23.50	(5.60)	30
COLUMN	19.84	(5.80)	125	23.32	(6.49)	124	21.57	(6.38)	249

Table 4

Treatment Group Means & Standard Deviations for Aptitude x Degree of Informative Detail x Type of Colour Cueing x Mode of Presentation (Definition Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent					
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n
A. Degree of Informative Detail:									
(low) Simple	20.36	(6.11)	64	24.26	(5.70)	61	22.26	(6.21)	125
(high) Complex	19.29	(5.45)	61	22.41	(7.09)	63	20.87	(6.51)	124
B. Type of Colour Cueing:									
Colour Cued	19.90	(5.52)	61	22.27	(6.62)	60	21.07	(6.21)	121
Non-Colour	19.78	(6.06)	64	24.31	(6.11)	64	22.05	(6.53)	128
C. Mode of Presentation:									
Inductive	18.11	(5.13)	66	20.50	(5.84)	62	19.27	(6.02)	128
Deductive	21.56	(5.69)	59	26.15	(5.17)	62	24.02	(5.85)	121
COLUMN	19.84	(5.80)	125	23.32	(6.49)	124	21.57	(6.38)	249

Table 5

Analysis of Variance for Scores on Line Drawing Posttest Items (Study I)

Source of Variance	SS	df	MS	*F*
A Colour/Non-Colour Treatments	1.106	1	1.106	0.08
B Simple/Complex Treatments	141.401	1	141.401	10.45*
C Inductive/Deductive Treatments	161.716	1	161.716	11.95***
D Field-Dependent-Independent Aptitude	816.918	1	816.918	60.36****
AxB	0.017	1	0.017	0.00
AxC	6.591	1	6.591	0.49
AxD	0.884	1	0.884	0.07
BxC	27.057	1	27.057	2.00
BxD	85.416	1	85.416	6.31*
CxD	2.330	1	2.330	0.17
AxBxC	71.710	1	71.710	5.30*
AxBxD	3.945	1	3.945	0.29
AxCxD	42.299	1	42.299	3.13
BxCxD	10.584	1	10.584	0.78
AxBxCxD	10.117	1	10.117	0.75
Explained	1407.626	15	93.842	6.93
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

* p <.025

** p =.001

*** p <.001

**** p <.0001

Table 6

Summary of Variance for Scores on the Line-Drawings Posttest Items, Including Tests for Simple Interaction Effects.
(Adapted from Keppel, 1973, pp.286-290, pp.325-327, pp.360-362; 1982, pp.304-309, pp.341-344; and Kirk, 1968, pp.222-224)

Source of Variance[1]	SS	df	MS	*F*
A Colour/Non-Colour Treatments	1.106	1	1.106	0.08
B Simple/Complex Treatments	141.401	1	141.401	10.45***
C Inductive/Deductive Treatments	161.716	1	161.716	11.95***
BxC	27.057	1	27.057	1.99
BxC at a_1	9.347	1	9.347	0.69
BxC at a_2	66.023	1	66.023	4.87*
AxBxC	71.710	1	71.710	5.30**
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

* $p < 0.25$

** $p < .025$

*** $p < .001$

[1] a_1 = colour-cued
a_2 = non-colour-cued

Table 7

Summary of the Analysis of Variance on Line-Drawing Test Items, Including Tests for Simple, Simple Main Effects
(Adapted from Keppel, 1973, pp.290-292, pp.326-327, pp.360-362; 1982, pp.309-311; and Kirk, 1968, pp. 222-223)

Source of Variance[1]	SS	df	MS	*F*
A Colour/Non-Colour Treatments	1.106	1	1.106	0.08
B Simple/Complex Treatments	141.401	1	141.401	10.45****
C Inductive/Deductive Treatments	161.716	1	161.716	11.95****
AxB	0.017	1	0.017	0.00
AxC	6.591	1	6.591	0.49
BxC	27.057	1	27.051	2.09
B at a_1 c_1	9.710	1	9.710	0.72
B at a_1 c_2	55.354	1	55.354	4.09*
B at a_2 c_1	132.046	1	132.046	9.76***
B at a_2 c_2	-	1	-	- [a]
C at a_1 b_1	94.090	1	94.090	6.95***
C at a_1 b_2	28.896	1	28.896	2.14
C at a_2 b_1	0.388	1	0.388	0.03
C at a_2 b_2	146.758	1	146.758	10.84****
AxBxC	71.710	1	71.710	5.30**
Residual	3099.174	229	13.534	-
TOTAL	4506.800	244	18.470	-

* p <.05   *** p <.01
** p <.025   **** p <.001

a the mean scores for these cells were equal

1. a_1 = colour-cued
a_2 = non-colour-cued
b_1 = simple line-drawing
b_2 = complex line-drawing
c_1 = inductive presentation
c_2 = deductive presentation

Table 8

Summary of the Analysis of Variance for Scores on Line Drawing Test Items, Including Tests for Simple Main Effects.
(Adapted from Keppel, 1973, pp.284-286, pp.360-362; 1982, pp.214-221, pp.235-236; and Kirk, 1968, pp. 179-182)

Source of Variance[1]	SS	df	MS	*F*
B Simple/Complex Treatments	141.401	1	141.401	10.45**
D Field Dependent-Independent Aptitude	816.918	1	816.918	60.36***
BxD	85.461	1	85.461	6.31*
B at d_1	3.717	1	3.717	0.27
B at d_2	236.221	1	236.221	17.45**
D at b_1	737.544	1	737.544	54.50***
D at b_2	188.149	1	188.149	13.90**
Residual	3099.174	229	3099.174	-
TOTAL	4506.800	244	18.470	-

* $p < .025$

** $p < .001$

*** $p < .0001$

1. b_1 = simple line-drawing
b_2 = complex line-drawing
d_1 = field-dependent aptitude
d_2 = field-independent aptitude

Table 9

Treatment Group Means and Standard Deviations for Field-Dependent and Field-Independent Aptitude (Line-Drawing Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent					
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n
1. Simple,Inductive,Non-Colour	10.00	(2.89)	19	13.93	(3.43)	15	11.74	(3.67)	34
2. Simple,Inductive,Colour	7.27	(3.47)	15	13.85	(2.91)	13	10.32	(4.60)	28
3. Complex,Inductive,Non-Colour	7.88	(3.04)	17	9.75	(3.45)	16	8.79	(3.33)	33
4. Complex,Inductive,Colour	8.53	(3.78)	15	10.44	(4.35)	16	9.52	(4.13)	31
5. Simple,Deductive,Non-Colour	8.54	(2.70)	13	14.47	(3.69)	17	11.90	(4.41)	30
6. Simple,Deductive,Colour	11.06	(4.07)	16	14.67	(3.75)	15	12.81	(4.27)	31
7. Complex,Deductive,Non-Colour	9.86	(4.90)	14	13.80	(3.63)	15	11.90	(4.66)	29
8. Complex,Deductive,Colour	9.80	(4.34)	15	12.07	(3.83)	14	10.90	(4.19)	29
COLUMN	9.15	(3.78)	124	12.84	(3.99)	121	10.97	(4.30)	245

Table 10

Treatment Group Means and Standard Deviations for Aptitude x Degree of Informative Detail x Type of Colour Cueing x Mode of Presentation (Line-Drawing Posttest)

TREATMENTS	APTITUDE						ROW		
	Field-Dependent			Field-Independent					
	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n	$\bar{X}$	(SD)	n
A. Degree of Informative Detail:									
(low) Simple	9.32	(3.56)	63	14.25	(3.42)	60	11.72	(4.27)	123
(high) Complex	8.97	(4.02)	61	11.45	(4.06)	61	10.21	(4.21)	122
B. Type of Colour Cueing:									
Colour Cued	9.20	(4.13)	61	12.69	(4.02)	58	10.90	(4.42)	119
Non-Colour	9.10	(3.45)	63	12.96	(3.78)	63	11.04	(4.20)	126
C. Mode of Presentation:									
Inductive	8.50	(3.30)	66	11.87	(3.54)	60	10.10	(4.04)	126
Deductive	9.90	(4.00)	58	13.80	(3.73)	61	11.89	(4.38)	119
COLUMN	9.15	(3.78)	124	12.84	(3.99)	121	10.97	(4.30)	245

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TITLE: A Supplantation Approach to the Design of
Instructional Visuals

AUTHOR: Margaret French

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A SUPPLANTATION APPROACH TO THE DESIGN OF INSTRUCTIONAL VISUALS

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A SUPPLANTATION APPROACH TO THE DESIGN OF INSTRUCTIONAL MATERIALS

Adaptation to the Individual Learner Through Media

Today's learner lives in a dynamic, multimedia environment. Advertizers, entertainers, politicians are some of those who have recognized the pervasive power of visual media to transmit information, to direct attention and to influence opinion. Many educators search to find ways of utilizing visual media in the learning environment. These educators may look to research to provide a guide to developing practical, effective methods of instructional design. A growing frustration lies in their criticism that it is difficult to relate many findings to a classroom setting.

This paper will propose an instructional design research model that incorporates factors which influence the effectiveness of variables as they interrelate in a learning situation. The following analogy seeks to illustrate the nature of these factors by relating the components of an effective consumer package to those of an effective learning package. The advertising world may consider several factors when developing market research. For the purpose of this analogy, the factors contributing to the effectiveness of a consumer package may be grouped into three major components.

Factors contributing to the product, or *what* the advertiser wishes to sell, represent the first component. The second group represents the consumer or the person *to whom* the product is directed. The third component is represented by the media characteristics which determine *how* the sales message will be communicated to the consumer. An ineffective advertisement fails to successfully integrate these three components. For example, a product may have no consumer appeal because it was aimed to the wrong consumer group, or it was presented in a way that had an unplanned, undesirable effect on viewers.

The same three components can be considered to exist as vital elements of a learning package. In education, these components are represented by the learning tasks (or what is to be learned), the learner (or the person to whom the instruction is directed), and the media (or how the message will be communicated). Ineffective instruction also fails to integrate these three groups of variables. For example, a student may fail to learn to operate complex apparatus not because of lack of psychomotor ability, but because of inability to interpret the visuals used to describe the procedures. The learner is deemed a failure when, in fact, the instructional visuals may have failed either by being inappropriate to the task, or by being inappropriate to the learning style of the student. In both business and education, integration of the three components is vital, whether the goal be an effective sales package or an effective learning program.

An educational research model which seeks to integrate the demands of the learning task with the aptitudes of learners and appropriate media characteristics has been termed "Aptitude Treatment Interaction" (ATI). This approach calls for a research methodology which considers the individual learner's characteristics in relation to the other components of the learning environment (Cronbach & Snow, 1977). The ATI approach to research seeks to match a learner's aptitudes with both learning task demands and appropriate methods of instructional presentation of learning and testing materials. To avoid "trial and error" searches for interactions, Cronbach & Snow have stressed the need for clearly defined studies, which systematically vary factors that describe the learner's aptitude in relation to the task demands and the attributes of the instructional media to be used. Several authors (e.g., Clark, 1975; Heidt, 1975, 1977; Cronbach & Snow, 1977) have stressed the need for taxonomies to provide a systematic way to describe and organize media attributes and subject aptitude variables. They suggest that a multivariate taxonomic approach may enhance applicability of results.

ATI methodology, when applied to educational research, hypothesizes an interaction between media attributes and learner aptitudes, which implies that a taxonomy of media attributes must be related to taxonomies used to classify learner characteristics. That is, the search for aptitude treatment interactions may be viewed as a survey of ways in which attributes of individuals and instructional treatments may interrelate (Cronbach & Snow, 1977). Cronbach & Snow's view is based on the assumption that the learning environment should be adapted to match the learner. This assumption has been applied by Salomon (1972, 1979) and Ausburn and Ausburn (1977, 1978) to include instructional treatments that provide for weaknesses and deficiencies in learner aptitudes. These authors have called these methods "supplantation approaches." Supplantation is based on the theory that learning will be most effective when the requirements of the task and methods of presenting information precisely complement the internal processing skills of the learner or adapt to the aptitude of each student. Ausburn and Ausburn (1977) proposed a supplantation model that would give assistance in designing instruction particularly when the learners' aptitudes were incompatible with the learning task requirements. In their model, the supplantation relationship between the learner and task was conceptualized as a connecting media "link," which may be incomplete due to a learner's inability to meet certain task demands. The link was viewed as a connection between learner and task that is facilitated through the use of supplantation techniques which form a "bridging mechanism" (Figure 1). In cases where a learner's aptitude capacities and the task requirements are made compatible through the use of appropriate media, the link is complete and performance is likely to be successful. However, when a discrepancy exists between learner capacities and task demands which is not overcome through the use of media, the link is likely to be incomplete and performance is expected to be poor (Ausburn and Ausburn, 1977).

A Supplantation Model for Instructional Design

Ausburn and Ausburn's original model (Figure 1) has been adapted in the present paper as illustrated in Figure 2. The present model takes a broader view of supplantation to incorporate viewpoints of other authors. Heidt (1977) has noted that a number of possible gradations of supplantation may exist within supplantation theory. The model illustrated in Figure 2 reflects this view by indicating that the degree/ amount of supplantation required is dependent on the degree of aptitude capacity of the learner. To a large extent, the learning task determines the nature of the learner operations to be supplanted.

However, the amount of supplantation depends on the aptitude capacities of the learner. Thus, if a learner has a high degree of operational capacity to meet a task's demands, then only a low degree of supplantation may be warranted. Conversely, if the specific aptitude of the learner is low, then a high degree of supplantation will be necessary. (See Figure 2.)

Figure 2 also indicates that supplantation approaches are affected not only by "degree of learner aptitude," but also by the attributes of the media available. In learning tasks, media may be used to activate and/or supplant certain cognitive processes. Thus, media have the power to influence learning processes through attributes which may have unique psychological and intellectual effects on a learner. These may be termed the "functional attributes" of media according to the learning functions they serve (cf. Heidt, 1977). These functions may include, for example, the power to guide, to inform, to emphasize, to reinforce, and to organize (Heidt, 1977).

All media have inherent attributes which define each medium's characteristics. Different attributes achieve different media functions. These functions are achieved through inherent differences in the structural attributes of each medium (Heidt, 1977). For example, the visual medium may utilize the structural attribute of color to achieve the function of increasing cue salience by emphasizing important information (cf. Allen, 1975).

The model illustrated in Figure 2 indicates four approaches to ATI that may utilize specific media attributes to create a supplantation "bridge" and facilitate successful task performance. These approaches represent a synthesis of ideas that have been discussed by Salomon (1972, 1979), Cronbach and Snow (1977) and Ausburn and Ausburn (1977, 1978). Within the context of the present model, these approaches may be described as follows. In Figure 2, the remedial, conciliatory and compensatory approaches exhibit a high degree of supplantation for low-aptitude learners in terms of completing processing gaps that may exist in the link between learner and task. The remedial approach may be represented by instructional materials that seek to train skills of low-aptitude learners through modeling and related techniques. For example, a study discussed by Salomon (1979) confirmed his hypothesis that low-aptitude subjects could improve their ability to attend to visual details with modeling through the use of a camera to zoom in on important information. Both the remedial and the conciliatory approaches are appropriate for low-aptitude learners. Whereas the remedial approach aims at retraining to increase performance, the conciliatory method merely provides an alternative processing option for these learners. The conciliatory approach utilizes a learner's preferred mode of processing (cf., Ausburn and Ausburn, 1978). It provides an alternative processing option for learners by capitalizing on processing modes preferred by a learner. The model depicted in Figure 2 shows a clear distinction between the conciliatory approach and the activation approach. In an activation condition, learners need some degree of aptitude to activate the appropriate processing operations from their repertoire of skills. Salomon (1979) has defined activation as an approach that can only benefit learners with a relatively high mastery of a skill. In contrast, the term conciliatory has been incorporated in the present model (Figure 2) to suggest an approach to overcoming a processing problem experienced by low-aptitude learners. In the context of Figure 2, both activation and conciliatory approaches capitalize on learners' strengths. The activation approach is defined as one which capitalizes on the skills of high-aptitude learners by freeing these individuals to use appropriate processing strategies. The conciliatory approach is defined as one which aids the low-aptitude learners by capitalizing on the use of alternative processing media preferred by these learners. In some instructional situations the application of approaches may be limited by constraints imposed by available practical resources; constraints may include the potentially high expenses of time, resources and money needed to provide alternative materials, for the conciliatory approach or alternative training materials for the remedial approach. Furthermore, convention often can determine the mode of instructional presentation. For example, an automotive mechanic is expected professionally to be capable of interpreting line-drawings in workshop manuals. Because of this expectation, a conciliatory approach (which would replace the line-drawing with a preferred mode) may not be appropriate on an instructional situation. In this instance, a mechanic limited in capacity to "read" line-drawings must either undergo remedial training or be provided with line-drawings designed to compensate for difficulties related to low aptitude. In the compensatory approach, the instructional materials "compensate for each learner's deficiency by providing the mode of presentation that the learner cannot provide for himself" (Snow, 1970, p 76). In other words, the compensatory treatments achieve for the learners what they cannot do for themselves (cf., Ausburn and Ausburn, 1978; Salomon, 1972). This is accomplished by developing instructional materials which circumvent a particular aptitude weakness. For example, French (1982) hypothesized that increasing the salience of important information would supplant the learner's capacity to discriminate relevant cues as a basis for generalization into concepts. She found that both high and low aptitude learners benefited from increased cue salience provided by simplified visuals presented with a verbal description of important concept cues. For high-aptitude learners, this treatment permitted efficient, effective performance without processing interference. For low-aptitude learners, this treatment may have been imperative for functional performance, as these learners utilized compensatory supplantation in order to meet a basic performance criterion. Thus, if a task requires learners to use a cognitive process for which they lack capacity or aptitude, "it may be possible to add to the treatment a prosthetic substitute for the learner to use just as an artificial limb is provided for the amputee" (Cronbach and Snow, 1977, p 170).

The Significance of Learner Control

Cronbach and Snow's notion of Aptitude Treatment Interaction is based on the assumption that the learning environment should be adapted to match the learner. That is, the educator, teacher or instructional designer plays the major role in deciding the best method to create the desired match. However, it has been argued that ATI and supplantation approaches may reduce the learners' contributions to their own learning and produce what Dansereau, Atkinson, Long and McDonald called "a disproportionate amount of emphasis on instructions for teaching to the exclusion of strategies for learning" (1974, p 9). Dansereau _et al_.

suggested that exclusive emphasis on teaching methods may lead to ineffective instructional manipulations, and may force students to develop non-transferable and inefficient strategies which could limit their cognitive awareness and performance. They referred to this threat as a loss of "learner control." Their argument has been supported by Merrill (1975) who questioned Cronbach and Snow's basic assumption that the environment should be adapted to the individual. To permit greater learner control, Merrill suggested that individuals should be given procedures that enable them to adapt the environment to themselves and their own needs.

Within ATI theory, some degree of learner control may be restored through the use of a remedial approach. In the remedial approach, the learner is actively trained to overcome processing deficiencies. However, there are strong limitations to sole use of this method. Many specific aptitudes are resistant to training and change. These aptitudes fail to adapt under training conditions (Cronbach and Snow, 1977). When limited in this way, educators may choose to apply either a conciliatory approach or a compensatory approach to supplant for the cognitive capacities of low-aptitude learners. Although the model in Figure 2 indicates that the remedial, conciliatory and compensatory approaches are appropriate for low-aptitude learners, these approaches differ in degree of learner control. The remedial approach is depicted as highest in learner control as it aims to cultivate processing skills through training, thus freeing learners to utilize their own strategies. The conciliatory approach is shown in Figure 2 to be lower than the remedial approach in learner control, because it imposes an external processing option on the learner and does not aim to cultivate skills. The compensatory approach is shown in Figure 2 to be lowest in degree of learner control because this approach often circumvents processing demands for the learner, and neither aims to cultivate nor to utilize strategies available to high-aptitude learners.

The Selection of an Appropriate Instructional Approach

The instructional designer needs to consider several factors when selecting an appropriate supplantation approach. Together with considerations of available practical resources and learner control, the nature of the task and its processing demands must be analyzed in relation to learner aptitude. If learners have the required processing attributes and skills, then an activation approach may be most appropriate. In situations where learners lack necessary processing capacities, the instructional designer can select either a remedial, conciliatory or a compensatory approach. The choice between remedial and compensatory approaches may be based on a determination of whether a large proportion of variance in the learning outcome is accounted for by task-specific capabilities. Fleishman and Bartlett (1969) have pointed out that task-specific capacities account for a significant proportion of achievement variance only in the relatively late stages of learning a skill. Early stages appear to correlate more highly with more general aptitudes which are not dealt with by the remedial model (Salomon, 1972). Furthermore, the remedial approach is appropriate when "the learning material is heirarchically or sequentially ordered" and "all the subordinate objectives on the heirarchy are learnable as a function of instruction"

(Salomon, 1972, p 332). These considerations may aid in determining whether the learner capacity should be trained (remedial approach) or compensated for (Salomon, 1972).

The practical implications relating to the selection of an appropriate approach are apparent in a recent discussion by Salomon (1979) of his studies relating to cue-attendance. Salomon has drawn a clear distinction between instructional treatments that: (a) "activate" cognitive processing (*cf.*, activation approach), (b) "short-circuit" cognitive processing demands (*cf.*, compensatory approach) and (c) overtly "model" processing operations (*cf.*, remedial and compensatory approaches). To illustrate the difference in the effects of these three treatments, Salomon discussed the results of experiments which explored the use of film to facilitate mastery of specific cognitive processing skills. Subjects in each of the treatment conditions were directed to write eighty details they noticed from each of three detailed paintings they had viewed. The modeling condition consisted of three films. The camera zoomed in on details and zoomed out to the entire picture eighty times within each film. This treatment was contrasted with the "short-circuiting" condition which consisted of a series of three slides of the same paintings. Within each slide series, a sequence of the entire picture then a detail, then the entire picture, then another detail, and so on were repeated eighty times. The details that were emphasized in this way were identical to those singled out in the modeling condition. A third treatment was included which Salomon termed the "activation" condition. Subjects in the activation condition viewed the three slides of the entire paintings. All subjects were pretested with tests of cue-attendance which served as a baseline measure upon which post-test scores could be regressed. Analyses of the post-test scores revealed that both the activation and modeling (supplantation) groups obtained significantly higher scores than the short-circuiting group. Activation and modeling tended to demonstrate the same degree of positive effects. A significant ATI was also indicated. Those subjects who scored low in the cue-attendance pretest benefited little from activation, but profited from the modeling condition. As hypothesized, activation called upon mediators not available to low-aptitude scorers. However, initially high scorers performed less well in the modeling condition and performed best following activation. Short-circuiting tended to favor the more skillful cue-attenders, though this condition did not lead to as large improvements as did the other two treatments.

Salomon noted that the three treatments can be arranged in a continuum, with activation at one end, supplantation (modeling) at the other and short-circuiting in-between. He points out that a defined medium could be placed on this continuum with respect to a particular person and task, and that it could, in effect, accomplish different functions along the continuum for different learners.

Salomon's findings suggest that two types of treatments can affect skill-mastery. First, a treatment may activate a skill by providing conditions that allow the skillful performer to utilize appropriate, previously partially mastered skills. Through activation it is expected to cultivate skill mastery with practice (Salomon, 1979). Second, a treatment may model the entire process for a low aptitude and over time the learner may be expected to cultivate the requisite skill (Salomon, 1979). The alternative short-circuiting treatment cannot really cultivate mastery of a skill "as it circumvents the need to apply the skill" (Salomon, 1979, p 134). In Dansereau's terms, a short-circuiting treatment may be low in learner control with a resultant loss in the learner's potential to cultivate effective strategies as a result of this compensatory approach.

The activation and modeling treatments allow for a high degree of learner control for both high- and low-aptitude performers because these methods seek to utilize and to improve the learner's aptitudes and capacities.

Implications of Aptitude-Sensitive Instruction

This paper supports a call for research directed towards more aptitude-sensitive instruction. In other words, instruction needs to be designed which not only considers the psychological effects of media attributes, but also considers the total effectiveness of the instructional package in terms of its sensitivity in meeting the processing needs of learner aptitudes that relate to the learning task. Pedagogical procedures need to acknowledge the relationship between the processing capacity of the learner and the processing demands of the task. Consequently, educators should tailor materials to fit the aptitude predispositions of learners. In so doing, they may promote a regard for the individual that is made possible through aptitude-sensitive instruction. Aptitude-sensitive instruction places emphasis on the single most important component of any educational experience--the learner.

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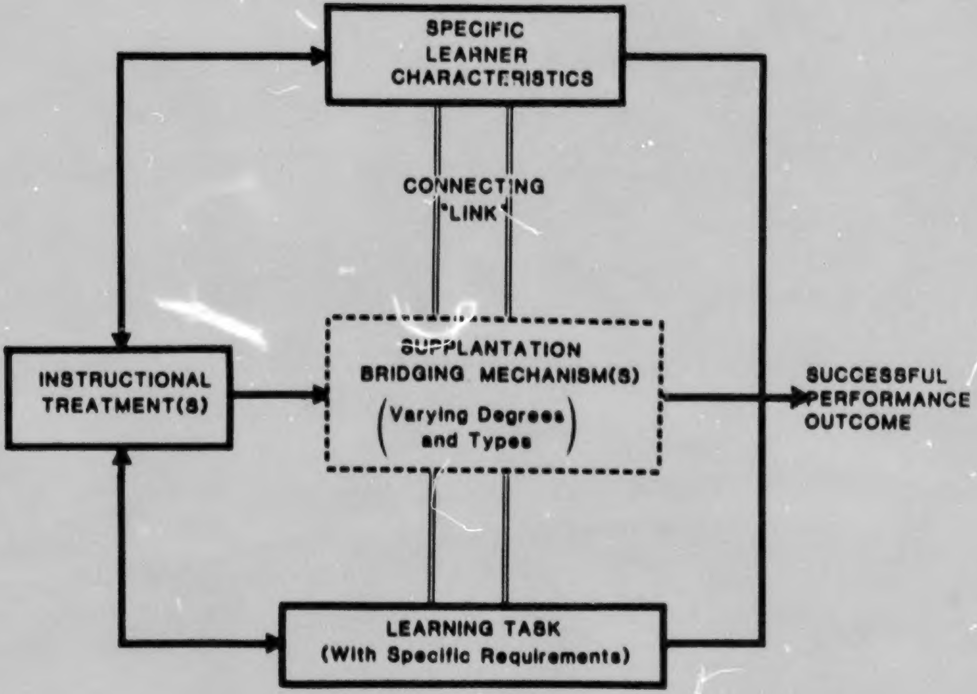
SPECIFIC LEARNER CHARACTERISTICS
CONNECTING "LINK"
INSTRUCTIONAL TREATMENT(S)
SUPPLANTATION BRIDGING MECHANISM(S)
(Varying Degrees and Types)
SUCCESSFUL PERFORMANCE OUTCOME
LEARNING TASK
(With Specific Requirements)

Figure 1: A Supplantation Model for Instruction Design

(From Ausburn, L.J. and Ausburn, F.B., A Supplantation Model for Instructional Design: A Preliminary Investigation. Paper presented at Annual Meeting of Association for Educational Communications and Technology, Miami, Fla., April, 1977. Reprinted by permission.)

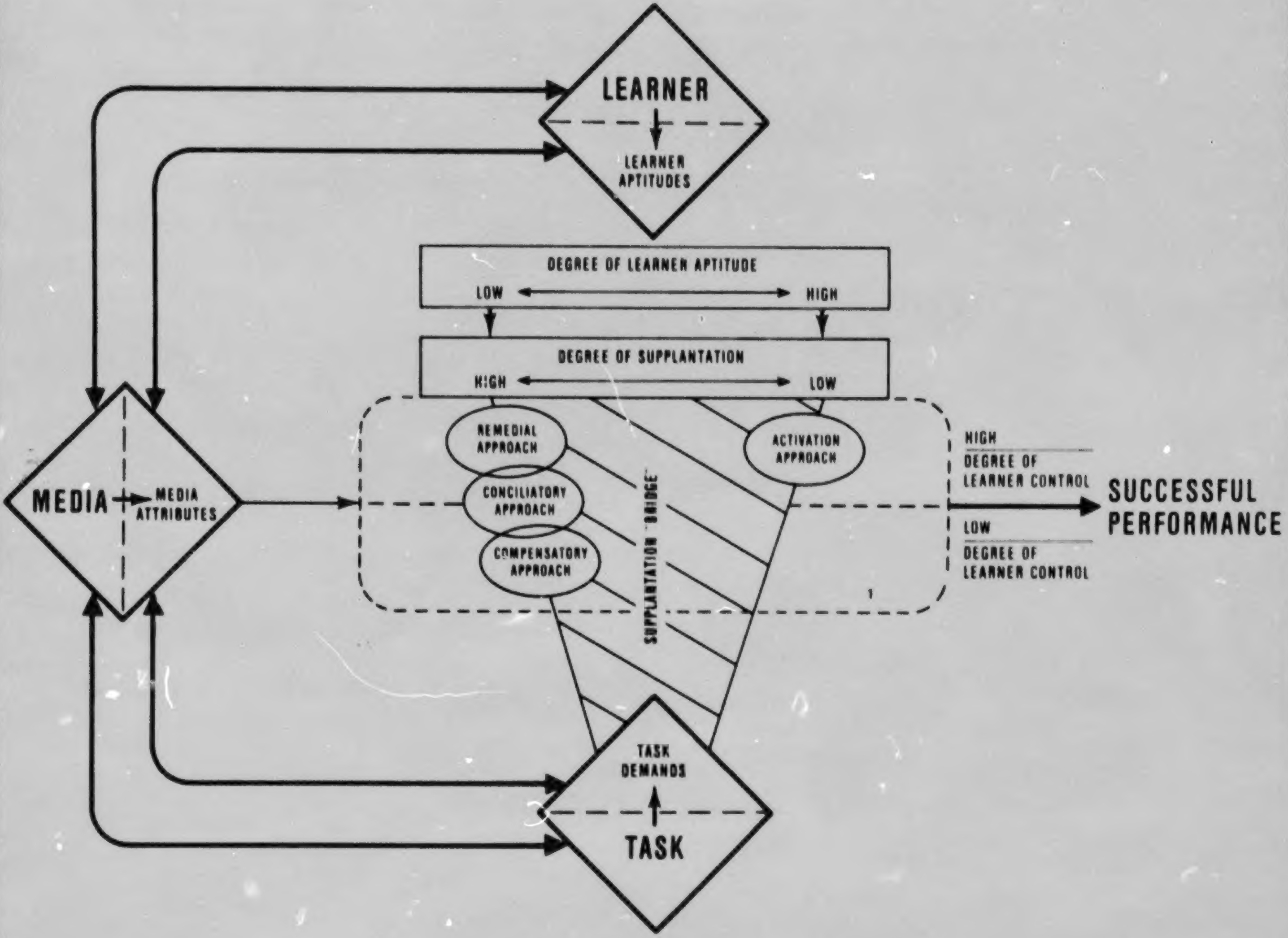
LEARNER
LEARNER APTITUDES
DEGREE OF LEARNER APTITUDE
LOW
HIGH
DEGREE OF SUPPLANTATION
HIGH
LOW
REMEDIAL APPROACH
CONCILIATORY APPROACH
COMPENSATORY APPROACH
ACTIVATION APPROACH
SUPPLANTATION "BRIDGE"
MEDIA
MEDIA ATTRIBUTES
HIGH
DEGREE OF LEARNER CONTROL
LOW
DEGREE OF LEARNER CONTROL
SUCCESSFUL PERFORMANCE
TASK DEMANDS
TASK

Figure 2: A Supplantation Model for Aptitude Sensitive Instruction

TITLE: The Impact of an Organizational Development Workshop On Participant Concerns About Teleconferencing

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The Impact of an Organizational Development Workshop On Participant Concerns About Teleconferencing

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Introduction

The purpose of this study was to determine the impact of an organizational development workshop on participant concerns about teleconferencing. The study answers the question Can an appropriately designed organizational development workshop help participants overcome a variety of concerns that are experienced as they participate in the change process?

Conceptual Framework

The advent of innovative telecommunications systems which are being implemented today in many organizations presents opportunities for significant research on the behavior of individuals involved in the change process. The adoption of an innovation is usually a gradual process through which individuals change their attitude and their behavior as they become increasingly more familiar with the use of the innovation (Bennis, Benne, Chin, Corey, 1976; Piele, Eidell & Smith, 1970; Maguire, 1970). Change in a technologically sensitive system is a process, not an event (Hall et. al., 1979). The study of change in an organization can be accomplished by using the individual as the frame of reference. That is, the adoption of an inovation can be judged by the level of use of the innovation within the organization and by the level of the concerns expressed by individuals who use the innovation.

Individuals in the process of change express a variety of concerns which indicate their attitude toward the innovation. Seven levels or stages of concerns can be identified during the adoption of an innovative program or project (Table 1). A profile of several different levels of concerns can be observed for each individual involved in the

TABLE 1

STAGES OF CONCERN ABOUT THE INNOVATION

0. AWARENESS: Little concern about or involvement with the innovation is indicated.

1. INFORMATIONAL: A general awareness of the innovation and interest in learning more detail about it is indicated. The person seems to be unworried about himself/herself in relation to the innovation. He/she is interested in substantive aspects of the innovation in a selfless manner such as general characteristics, effects and requirements for use.

2. PERSONAL: Individual is uncertain about the demands of the innovation, his/her inadequacy to meet those demands, and his/her role with the innovation. This includes analysis of his/her role in relation to the reward structure of the organization, decision making and consideration of potential conflicts with existing structure or personal committment. Financial or status implications of the program for self and colleagues may also be reflected.

3. MANAGEMENT Attention is focused on the processes and tasks of using the innovation and the best use of information and resources. Issues related to efficiency, organization, managing, scheduling, and time demands are utmost.

4. CONSEQUENCE: Attention focuses on impact of the innovation on student in his/her immediate sphere of influence. The focus is on relevance of the innovation for students, evaluation of student outcomes, including performance and competencies, and changes needed to increase student outcomes.

5. COLLABORATION: The focus is on coordination and cooperation with others regarding use of the innovation.

6. REFOCUSING: The focus is on exploration of more universal benefits from the innovation, including the possibility of major changes or replacement with a more powerful alternative. Individual has definite ideas about alternatives to the proposed or existing form of the innovation.

adoption of an innovation. Over a period of time, it is expected that this profile will change, thereby indicating that an individual has progressed from lower level informational concerns, to personal concerns, and finally to impact level concerns, i.e., consequence, colloboration and refocusing. Progression through various levels of concern is predicted to be rapid for the lower level personal concerns and slower (up to three years) for impact level concerns. For example, an individual will move rapidly through the awareness, informational, personal, and management levels of concern, and more slowly through the consequence, collaboration, and refocusing levels. The Concerns Based Adoption Model of Hall (CBAM), can be used to develop research studies which assess changes in the level of concerns expressed by individuals as they become increasingly more familiar with an innovation (Hall 1976). This model can also be used as a guide for instructional developers and change facilitators as they attempt to choose appropriate intervention strategies to enhance the acceptance of an innovation. In addition, this model can provide instructional developers and change facilitators a tool by which they can assess the current level of concerns of individuals involved in the change process and then prescribe experiences which focus on specific concerns. Use of the model in this sense makes it a valuable diagnostic and prescriptive tool in the change process (Hall 1976; Hall & Loucks, 1977, 1978a, 1978b, Hall, Zigarmi, & Hord 1979). Whether or not an innovation is adopted by potential users often depends upon the user's needs and the ability of the innovation to meet those needs (Havelock, 1973; Rogers, 1968). Establishing the relationship between a user's needs and the capabilies of the innovation to meet those needs is a frequent role played by change agents (Havelock 1973, Rogers, 1972, Rogers and Shoemaker, 1971).

Background

The University of South Dakota School of Medicine recently established a state-wide teleconferencing network, the South Dakota Medical Information Exchange (SDMIX). The SDMIX staff assumed the role of change agents in their efforts to gain acceptance of teleconferencing as an instructional medium within the state of South Dakota. The SDMIX staff designed an organizational development workshop to address the needs and concerns of teleconference presenters (Hancock and Chute, 1982, Chute, Hancock, and LaPierre, 1982). The results obtained from a study designed to assess the effects of this workshop on participant concerns are presented.

Purpose

The purpose of this study was to evaluate the effectiveness of an organizational development workshop which was designed to address participant concerns about teleconferencing. It was hypothesized that the SDMIX workshop would reduce the concerns of participants at the lower levels of the CBAM while not significantly increasing their level of concerns at the upper levels of the CBAM (Table 1).

Subjects

The subjects in this study were 25 health care professionals from a five hospital system which is extensively involved in in-service training. The employees came from different medical backgrounds, i.e., technicians, nurses, social workers, and administrative personnel. There were 11 men and 14 women ranging in age from 25-66. Sixteen subjects had never participated in a teleconference, seven had participated in one teleconference, and two had participated in less than four teleconferences.

Table 2

	Number of Teleconferences			
	0	1	2	3
Nunber of Subjects	16	7	1	1

Treatment.

The SDMIX teleconference workshop was designed to address the concerns of the participants. It was based on a plan derived from the change model of Havelock (1973) and CBAM of Hall (1979). The five stage SDMIX workshop plan followed an organizational development approach.

SDMIX Workshop Plan

1. Determining Presenter Needs and Concerns
2. Creating Awareness and Interest in Teleconferencing
3. Providing Information about Teleconferencing
4. Teaching Teleconferencing
5. Changing Participant Attitudes and Behaviors

(Hancock and Chute, 1982)

There were three phases to the workshop. The first phase occurred during a three hour morning session in which participants were shown how teleconferencing can be used to meet their needs. They were also shown how to incorporate design techniques into a teleconference presentation. The second phase of the workshop took place on the same afternoon. In this session participants were divided into small groups and with the assistance of the workshop staff began to develop a teleconference presentation. The third phase of the workshop occurred approximately three weeks after the initial two phases. During the third phase of the workshop, which was teleconferenced, participants presented the topics they had begun to develop during the second phase of the workshop. This separation of the second and third phase of the workshop allowed participants time to research the topic which they wished to present and also allowed for the production and distribution of duplicate sets of audiovisual and handout materials.

Instrumentation.

An 18 item questionnaire designed by the authors was employed to assess participant concerns at the informational, personal, management, consequence, collaboration, and refocussing levels of Hall (Table 1). Questionnaire items were developed from lists of concerns expressed by participants at two previous workshops. For each of the six levels, three items were selected. These items were submitted to a panel of experts to determine their validity; the instrument was judged to be a valid measure of the six levels of the concern described in the CBAM. The participants indicated their level of concern on a five point scale (0=no concern to 4=high concern) for each of the 18 items. The awareness level was not included on the questionnaire as participant involvement in the workshop established that they were aware of teleconferencing. Two forms of the questionnaire were produced. On each of the

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forms, A and B, the items were randomly ordered. Each time the forms were administered half of the participants completed form A and half of the participants completed form B. The instrument had a reliability of .70 determined using the Cronbach Alpha.

Design

A repeated measures design was used in this study. Subjects were administered the concerns questionnaire at three different times: prior to phase one of the workshop, after phase two of the workshop, and after phase three of the workshop. Figure 1 illustrates the design used in this study. An ANOVA for repeated measures was employed as the statistical test for the study.

O X X O X O

Where:

O = pretest
X = workshop presentation (Phase 1)
X = participants assisted in designing a teleconference (Phase 2)
O = second administration of the questionnaire
X =participants present their teleconference (Phase 3)
O = third administration/after teleconference presentation

Figure 1: Measurement of the change in participant concerns.

Results

The results of the ANOVA for repeated measures indicated statistically significant changes in participant concerns at the: informational level, F=63.55 p<.001; personal level, F=43.26, p<.001; management level, F=9.86, p<.001; and consequence level, F=39.22, p<.001. Changes in the collaboration and refocusing levels were not statistically significant. Table 2 summarizes the results.

Table 2

Summary of the Changes in Participant Concerns

Concern Level	Observation Ob1	 Ob2	 Ob3	F	p
Information	2.49	1.20	0.84	63.55	<.001
Personal	2.20	1.27	1.09	43.26	<.001
Management	2.83	2.44	2.08	9.86	<.001
Consequence	2.95	2.19	1.74	39.22	<.001
Collaboration	2.53	2.56	2.71	0.35	>.001
Refocusing	2.60	2.40	2.47	0.45	>.001

*Ob1-3 = the means for Observations 1-3

Discussion

The results of this study suggest that the organizational development workshop was effective in reducing the concerns held by workshop participants at the informational, personal, management, and consequence levels. This was predicted by the CBAM. The results also indicate that changes in the collaboration, and refocusing levels were not statistically significant. This was also predicted by the CBAM. The CBAM predicts that changes in the level of concerns at the impact level are likely to occur only after repeated successful experiences with an innovation. This frequently takes from one to three years.

The subjects in this study were from the medical field where the accepatance of technological innovations is a necessity. this may explain the significant changes in concerns and the willingness to accept the innovation of teleconferncing. in addition, the mid-point on the scale for participants to express their concern was 2.0, (concerns scale: 4,3,2,1,0). The means for the informational, personal, management, and consequence ranged from 2.0 to 3.0 implying that the concerns at these levels were not initially very high.

Summary

With the advent of an innovation such as teleconferencing there is generally a period of cautiousness, or a trial stage, until the innovation is adopted. This study attempted to assess the effects of an organizational development workshop designed to address the concerns individuals have about teleconferencing. The purpose of the workshop was to reduce the concerns typically held by individuals in the adoption of an innovation. The workshop was successful in reducing the informational, personal, management, and consequence levels of concern as expressed by

Hall's Concerns Based Adoption Model. The collaboration and refocusing levels of concern were not changed as a result of the workshop experience.

TITLE: A Comparison of Factors Affecting Elective Participation in Computer Coursework

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A Comparison of Factors Affecting Elective Participation in Computer Coursework

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Abstract

A total of 115 high school students were surveyed in order to determine the factors affecting elective participation in introductory computer coursework. Differences in responses were also analyzed as a function of computer experience and sex of student. The results indicated significant computer experience differences in perceptions of science and mathematics needed for entry-level computer courses, as well as for perceptions of competence in each area. Experienced students rated the mathematics and science demands lower than inexperienced students. Achievement differences were also detected, with experienced students attaining higher levels of achievement than inexperienced students. Inexperienced students appear to overestimate the complexity of introductory computer courses, and as a result either postpone their participation or elect not to participate.

A Comparison of Factors Affecting the Elective Selection of Introductory Computer Courses

The growing impact of computer technology in education has been studied from a number of perspectives. The focus of such research has ranged from predicting success in computer coursework (Fowler & Glorfeld, 1981; Peterson & Howe, 1979), to examining teacher and student attitudes toward computers (Beck, 1981; DeBlassio & Bell, 1981; Jenkins & Dankert, 1981; Stevens, 1980), to measuring the effects of student cognitive style on computer effectiveness (Cheney, 1981).

Despite this apparent abundance of current research, however, little is known regarding the factors affecting the initial voluntary selection of computer coursework. In related areas, for example, parental influence (Wilhelm & Brooks, 1980) and perceived career usefulness of the coursework (Pedro, Wolleat, Fennema, & Becker, 1981) have been found to influence student participation. Academic achievement and attitudes, especially in mathematics and science (Beck, 1979; Peterson & Howe, 1979), have been associated with success in computer coursework. This may be a telling trend, given the well-documented differential achievement and attitude patterns for males versus females in these areas. It is not known, however, why individuals choose to enroll initially in computer coursework. This is especially problematic for high school students whose preliminary career choices are at a formative stage.

The issue of why, or perhaps more importantly why not, computer courses are voluntarily selected by high school students is important for several reasons: 1) students at this age are in the process of formulating career choices, and in doing so indirectly prescribe their formal training needs; 2) with few exceptions, computer courses are offered as "electives" at the high school level, and as a result the issue of selection influences becomes increasingly important; 3) the rapid projected growth forecast for the computer field by the United States Department of Labor Statistics (Carey, 1981) will require a significantly broader literacy base in the work force than currently available (see also Dickerson & Pritchard, 1981; Molnar, 1978); 4) early exposure to computer technology may help to reduce the amount of mid-career retraining needed as industry becomes more computerized; 5) students' decisions regarding elective computer coursework may be based upon erroneous perceptions (cf. Beck, 1979; Cole & Hannafin, Note 1); and 6) strategies for systematically modifying student misperceptions regarding computer coursework may be developed and implemented, resulting in a greater level of voluntary participation.

The purposes of the present study were to identify the factors affecting the voluntary selection of computer coursework and to examine differences among such factors as a function of prior computer coursework experience and sex of student.

Methods

Subjects

A total of 115 high school students from grades 10 through 12, 71 males and 44 females, participated in the study. Students were enrolled in one of three middle-class suburban high schools, each with documented standardized achievement levels at or above national averages. The schools were selected from the same school district since an identical introductory computer course was offered on an elective basis at each. Students were considered to be representative samples of individuals who had either previously taken, were currently enrolled, intended to take, or had no intention to take introductory computer course.

Materials

A written Student Perception Survey was employed. Pairs of survey items were used to determine student perceptions of the amount of mathematics, science, and intelligence needed for learning of computer skills, and the degree to which students perceived themselves as possessing the needed skills. In addition, items pertaining to perceived career value and parent importance were included. The survey included the following items:

1. Science skills are very necessary to learning computer skills.
2. I feel I have the science skills necessary to learn computer skills.
3. Mathematics skills are very necessary to learning computer skills.
4. I feel I have the mathematics skills necessary to learn computer skills.

5. Only people who are intelligent use computers.

6. I feel I am intelligent enough to use computers.

7. Use of computers will be a required skill for jobs in the next 20 years.

8. Use of computers will be necessary for jobs I intend to have in the next 20 years.

9. My parents feel that computer skills will be important in the future.

The scale items were rated on a Likert-type scale, from Strongly Disagree to Strongly Agree, with corresponding values ranging from 1-5.

Procedures

Students, identified as having previously taken, currently taking, planning to take, or not planning to take an introductory computer course were administered the Student Perception Survey. Students were informed that their school was seeking information to identify and meet student needs regarding computers, but that their participation in the study was voluntary. At no time were students informed that response comparisons were to be made, nor were they informed as to the sampling procedure governing their selection. The surveys were administered during a two-week period.

In addition to the survey data, standardized mathematics and science achievement test scores were collected for each participant.

Design and Data Analysis

Two factors, computer experience and sex of student, were included. Four levels of computer experience (Taken, Taking, Will Take, Won't

Take) were crossed with sex of student (Male, Female). Survey data were analyzed using two-way Analysis of Variance procedures, to test for differences in item responses for perceived mathematics needed and mathematics possessed, perceived science needed and science possessed, and perceived intelligence needed and intelligence possessed. Differences in the perceived importance of computers in general and for the specific career plans of individual students, as well as differences in students' estimates of perceived parent importance of computers, were similarly analyzed.

Performance-based analyses were conducted to test for differences in achievement patterns as a function of computer experience and sex of student.

Results and Discussion

Mean item responses for the Student Perception Survey are contained in Table 1, and mean achievement scores are contained in Table 2. The results are discussed below by factor.

Insert Table 1 and Table 2 about here.

Science Skills

Needed. Significant differences were obtained for ratings of science skills needed as a function of computer experience,

$F(3,107)=4.60$, $p<.005$. Experienced students who had either previously taken (2.75) or were currently taking (2.90) computer coursework rated science skills as less essential to the learning of introductory level computer skills than inexperienced students either planning to take (3.60) or not planning to take (3.30) such coursework. In effect, students with prior computer experience did not perceive science skills as critically as inexperienced students to the learning of entry-level computer skills. It is likely that first-hand experience diminishes the perceived science difficulty of computer coursework, while the lack of such experience results in an overestimation of the science-related demands of computer coursework. This overestimation of coursework difficulty may be an influential factor deterring many students from participation in computer coursework. No differences were obtained for the ratings of male versus female students.

Competence. An experience effect was also found for perceived science competence, $F(3,107)=3.18$, $p<.05$. Students not planning to take computer coursework obtained lower perceived competence levels (3.15) than either students taking (3.73) or planning to take (3.72) courses. The inclination to participate in computer coursework appears to be affected heavily by perceptions of adequacy in the assumed science skill requirements. Students with no inclination to participate apparently perceive computer coursework as requiring significant science aptitude, and perceive themselves as incapable of meeting the perceived science demands. Again, no differences were found between the ratings of males and females, although males reported generally greater confidence in their science skills than females.

Achievement. Although no significant differences were found for either experience or sex of student, a number of consistent trends were identified. Mean score performance levels, for example, resulted in a predictably linear trend as a function of experience, with students who had taken courses obtaining the highest mean score (74.78), followed by those presently taking (66.85), students planning to take (60.94), and students not planning to take computer coursework (55.72). This trend further supports the finding that students most inclined to participate are generally more able in science than those with no plans to take such courses, although the legitimacy of the perceptions of course difficulty and competence to meet course demands may be without justification. A pattern was also detected for sex of student, with males (66.76) obtaining higher achievement levels than females (56.41).

Mathematics Skills

Needed. Marginally significant differences were found for experience, $F(3,107)= 3.24$, $p<.05$, with students taking and planning to take yielding the largest differences in ratings of mathematics skills needed to learn computer skills. In contrast with the findings regarding perceived science needed, the trend obtained for mathematics needed was not as clear-cut. Although experience was a factor in the reported differences, no differences were found between the ratings for the most experienced group, those who had already completed the course, and those with no intention to take the computer course. In addition, obtained differences were marginal ($p<.05$) in magnitude, suggesting that perceptions of mathematics needed for learning computer skills may not be differentiated strongly by experience. Consistent with the findings for science, males and females rated the importance of mathematics in learning computer skills comparably.

Competence. Ratings of mathematics competence were found to be affected significantly by both experience, $F(3,107)= 4.51$, $p<.005$, and sex of student, $F(1,107)= 5.20$, $p<.025$. Students who had already taken computer coursework indicated greater confidence in their mathematics skills (4.45) than either those presently taking (3.67) or students with no plans to take computer coursework (3.63). The results are consistent with the findings for science, suggesting that perceptions of adequacy to meet the mathematics demands of computer coursework improve as a function of first-hand experience. Also consistent with the findings for science was the pattern of responses for male (4.01) versus female (3.61) students, suggesting that male students perceive themselves as more capable mathematically than female students in the learning of entry-level computer concepts.

Achievement. Significant differences were found for experience, $F(3,85)= 3.10$, $p<.05$, sex of student, $F(1,85)= 3.71$, $p<.05$, and the experience-by-sex of student interaction, $F(3,85)= 3.69$, $p<.01$. Consistent with the findings for science, mathematics achievement was predictably linear as a function of experience, with students who had previously taken computer coursework demonstrating the highest levels of achievement (78.22), and those with no plans to take computer coursework obtaining the lowest achievement level (54.43). Also consistent with the findings for science, males out-performed females overall (68.13 vs. 54.41), but the effect was not uniform across experience. Females who had previously taken computer coursework demonstrated high achievement, while the remaining female groups scored consistently lower than their male counterparts. These results suggest that more able high school students appear to be inclined toward enrolling in computer coursework, and that males generally out-perform females mathematically. This trend, however, is moderated by the interaction between experience and sex of student, with experienced males and females attaining comparable levels of mathematics achievement.

Perceived Importance

Students rated computer importance virtually identically across experience and student sex. Students at each level of experience rated computer skills as very important during the next 20 years, both in general and for the specific career plans of the student. In effect, students with no plans to take computer coursework perceive computers as important to their future career, but still indicate no intention to participate in computer-related coursework. Unlike previous studies, perceived career importance had little effect on high school students' decisions to take, or not to take, computer coursework.

Parental Influence

Similar to the findings for perceived importance, students rated parents perceptions of the importance of computers consistently high across sex of student and experience. According to student responses, parents appear to perceive computers as important for male and female students, regardless of whether or not computer coursework has been, is currently, will be, or will not be taken by the student. Based upon the uniformity of these reports, it seems unlikely that parental influence is a dominant factor in differentiating student selection of computer courses.

Intellectual Skills

No differences, main effects or interactions, were found for either the perceived intellectual skills needed to learn entry-level computer skills or the skills possessed by students. In contrast with the consistent differences found for mathematics and science, students appear to differentiate between overall intellectual ability and the specific academic skills correlated with computer coursework. Selection does not appear to be moderated by perceptions of intellectual ability or inability to learn entry-level computer coursework.

General Discussion

The purposes of the present study were to identify the factors affecting the voluntary selection of introductory computer courses, and to examine differences in the influence of such factors as a function of prior computer coursework experience and sex of student. The results indicated that student course selection may be affected by perceptions of the science and mathematics required of computer courses, but appears not to be affected strongly by such influences as parent attitudes towards computers, perceived career value, or the perceived intellectual demands of computer coursework.

The findings regarding student perceptions of the role of mathematics and science, and their perceived competence in these areas, were perhaps the most important findings of this study. Experienced students perceived science and mathematics as less critical than inexperienced students. This trend could be the result of increased sensitization to the actual academic demands of computer coursework on the part of experienced learners. It is also possible that these students were simply more able in academic areas, and did not perceive the mathematics or science components of introductory computing as especially challenging. It is important to note, however, that inexperienced students may be overestimating the complexity of the coursework, electing not to attempt such perceptably difficult work, and failing to gain needed background in an area of admittedly high career importance. If this is the case, perhaps high school administrators need to reevaluate the image, as well as the science and mathematics demands, of introductory computer courses. If such courses require extensive mathematics and science background, the structure of introductory level instruction may need to be reassessed. This is especially true in light of the growing demand for a computer literate future work force. If introductory course content is being misperceived by students, however, and does not place extraordinary mathematics or science academic demands on students, then perhaps sources of misconception can be ameliorated through direct student, faculty, and parent awareness programs.

Based upon mean item responses, students appeared to identify computers more closely with science than the other areas included in the study. The reasons for this difference are debatable. Such perceptions may be affected implicitly by expressions such as "computer science". In addition, the computer courses offered by the schools in the present study were taught through science departments. The uninitiated or inexperienced student would be most likely affected by departmental affiliation and linguistic tags such as "computer science" since they would have no first hand referent as to what computers actually entailed. Perceived inability in science, under such circumstances, is likely to be a serious deterrent to course selection.

Of further interest were the findings that student selection seemed not to be affected by influences such as the students' perceptions of parental attitudes and perceived importance. It was assumed that perceived career value and parent influences would be strong differentiating factors in the selection of computer courses. Although students appeared unanimous in their endorsement of computers as important to future career plans, significant numbers of students continue to indicate no plans to receive computer training. It appears that student selection behavior is affected primarily by perceptions of academic content and adequacy in meeting the assumed academic demands, and not by perceptions of the importance or usefulness of computers.

The finding that students differentiated between academic skills and intellectual ability is also important from a practical standpoint. Student response paterns to the perceived academic demands of science and mathematics were clearly different from the more global notion of intelligence. It appears that students of both sexes and of varied computer experience do not perceive the computer as the province of the intellectually gifted, but more as an area for students of high math or science aptitude. This is a potentially important distinction since specific planned strategies can be implemented to dispell misconceptions regarding specific academic areas. However, perceptions of intellectual inability are likely to be more ingrained and less malleable. The potential for resolving student misperceptions of the academic demands of introductory level computer classes appears feasible.

While it has become clear that certain computer-related perceptions vary with experience, it is not known to what degree these perceptions are modified by, or dictate, computer experience. It would be an oversimplification to assume that favorable student perceptions are formed exclusively through computer courses; in many case, it is likely that students with positive attitudes migrate toward computer courses initially. However, the same is likely true of students who choose not to participate. In the same sense that positive perceptions attract students, negative perceptions are likely to discourage students. If perceptions dictate experience to a significant extent, then the accuracy of such impressions needs to be validated. It may be unrealistic to expect that all presently disinterested students will select computer courses in the future. Yet it seems reasonable that a significant percentage of students not presently participating due to misperceptions of the focus, prerequisites, and assumptions of introductory computer coursework, can be attracted with needed clarification. Future research may help to clarify further sources of misperception, as well as the modifiability of such perceptions.

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Table 1

Mean Ratings for Perceived Skill Requirements

Perceived Skill Requirements	Experienced		Not Experienced		
	Taken	Taking	Will Take	Won't Take	Total
Science Skills					
Needed					
Male	2.86	2.86	3.62	3.39	3.17
Female	2.50	3.00	3.53	3.18	3.16
Total	2.75	2.90	3.60	3.30	3.17
Competence					
Male	3.57	3.90	3.69	3.17	3.56
Female	3.50	3.33	3.75	3.12	3.39
Total	3.55	3.73	3.72	3.15	3.50
Mathematics Skills					
Needed					
Male	4.36	3.86	4.85	4.09	4.21
Female	4.00	3.89	4.33	4.06	4.09
Total	4.25	3.87	4.60	4.07	4.17

Table 1 (cont.)

Perceived Skill Requirements	Experienced		Not Experienced		Total
	Taken	Taking	Will Take	Won't Take	
Mathematics Skills (Cont.)					
Competence					
Male	4.50	4.00	4.08	3.70	4.01
Female	4.33	2.89	3.92	3.53	3.61
Total	4.45	3.67	4.00	3.63	3.86
Intellectual Ability					
Needed					
Male	2.21	2.09	2.46	1.87	2.11
Female	1.83	2.38	2.00	1.94	2.02
Total	2.10	2.17	2.24	1.90	2.08
Competence					
Male	4.14	4.09	4.46	4.00	4.14
Female	4.00	3.75	4.25	4.11	4.07
Total	4.10	4.00	4.36	4.05	4.11

Note. Item values ranged from Strongly Disagree(1) to Strongly Agree(5).

Table 2

Mean Percentile Achievement Scores

by Computer Experience and Sex of Student

	Experienced		Not Experienced		
Sex of Student	Taken	Taking	Will Take	Won't Take	Total
Mathematics Percentile					
Male	76.08	75.06	69.18	56.50	68.13
Female	83.80	61.50	51.88	52.00	54.41
Total	78.22	68.37	61.89	54.43	63.41
Science Percentile					
Male	78.08	68.32	70.67	57.14	66.76
Female	66.20	62.86	50.00	53.88	56.41
Total	74.78	66.85	60.94	55.72	62.93

Note. Achievement data incomplete for a total of 22 students, accounting for the difference in total n's and degrees of freedom in ANOVA.

TITLE: Experiencing the Image: Visualization's Role
in Educational Technology

AUTHOR: John A. Hortin

EXPERIENCING THE IMAGE: VISUALIZATION'S ROLE IN EDUCATIONAL TECHNOLOGY

By

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Paper Presented at the 1983 Association
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Abstract

Visual thinking has had a relatively modest role in the field of educational technology. Advances in science and neurophysiological research enable researchers to study brain chemistry, biofeedback, computer simulation of human thinking, and visualization. This paper reviews some of the research and theories on mental imagery and visual thinking and provides suggestions for new strategies for instructional design through mental rehearsal and visual thinking. Experiencing the image is the process of using images of the mind to practice behavior prior to the actual event. Thus, experiencing the image is a method for preparing and planning for the future by creating visual events of the mind. The paper also discusses current research in the area of visualization, focusing on its practical applications. Instructional technologists should be involved on a more sophisticated level of instructional design through learning how to experience the image and showing others how to do so as well.

The study of how people think and especially how they think visually has had a relatively modest role in the field of educational technology. Except for the efforts of a few educational technologists like Malcolm Fleming, William Winn, Gavriel Salomon, James Knowlton, Howard Levie, Frank Dwyer and Jack Debes, theorists and researchers in educational technology have not brought educators very far toward applying visual thinking to instructional design or media utilization. Rather, it is advances in general technology and recent neurophysiological research that enable researchers to study brain chemistry, left and right brain hemisphere phenomena, biofeedback, computer simulation of human thinking, and visualization. Also, educational theory in cognitive style, Gestalt psychology, phenomenology, visual literacy, symbol systems and intuitive learning has rekindled interest in the study of mental processes.

Perception, learning, memory, transfer and thinking are some of the cognitive processes that educators, psychologists, and educational technologists have investigated in their research. I wish to concentrate on the thinking process and, more specifically, on the role of visual thinking, visual rehearsal and introspection in the field of educational technology.

Mayer (1977) describes thinking in the following way:

> Thinking is cognitive, but is inferred from behavior. It occurs internally, in the mind or cognitive system, and must be inferred indirectly.
>
> Thinking is a process which involves some manipulation of, or set of operations on, knowledge in the cognitive system.
>
> Thinking is directed and results in behavior which 'solves' a problem or is directed towards solution. (p. 6).

Although there is no full agreement in psychology about what thinking is, I prefer the problem solving characteristics Mayer (1977) describes - mainly because he describes essentially what I have found that many students say they do when they solve problems and puzzles I have given them. For instance, if I ask my students to think aloud or through introspection to ask themselves how they arrive at the answer to a particular question, I find them verbalizing, visualizing, acting out the situation, adding and subtracting information, seeking relevant information and sorting through various stimuli. They experience all types of imagery: visual, aural, kinetic, olfactory, gustatory, and haptic. Obviously, people vary in the degree to which they use their inner images to solve problems.

In the research I have been conducting on visualizing answers to visual thinking problems, I have found that students make internal mental representations (Hayes, 1981, p. 3) of the problems and puzzles presented to them. They also make external representations (Hayes, 1981, p. 11) on paper of their internal representations. These internal representations help the students visualize situations, act out the situation, see the problem from alternative perspectives, and rehearse the scenario in order to try out possible solutions. The external representations help students keep track of decisions made, of knowledge discovered and of relevant information used as opposed to the irrelevant information that was not used. Therefore, internal and external representations are crucial aspects of experiencing the image. Sample questions (Hortin, 1981) presented to the students in class include the following:

1. A dwarf lives on the twentieth floor of a skyscraper. Every morning he goes into the elevator, pushes the correct button, and is taken to the ground floor; he goes off to work and comes back in the evening. He enters the lift, pushes the button, and goes up to the tenth floor; he then walks up the rest of the stairs. The question is: Why doesn't he go up to the twentieth floor in the elevator? (Eysenck, 1966, p. 9)
2. My house faces the street. If a boy passes by my house walking toward the rising sun, with my house at his right, which direction does my house face? (McKim, 1972, p. 15)
3. If Tom is shorter than Dick, and Harry is taller than Dick, is Tom taller or shorter than Harry? (Albrecht, 1980, p. 43)

Students are encouraged to use their internal representations and external representations to solve these problems, that is, to sketch, count on their fingers, move about, feel (mentally) their way through the problems. Thinking out loud, recording on tape, sketching a map, and drawing figures are some of the behavioral responses that I have seen. In the first problem some students correctly visualized the dwarf trying to reach the highest button on the elevator and not being able to reach higher than the tenth floor button. Others reasoned verbally that this particular elevator went only to the tenth floor and that another elevator on the tenth floor took passengers up to the twentieth floor. Unfortunately, they added incorrect information. Although, in some apartment complexes of our cities, there are some elevators that go only to certain floors and this solution for the first problem is plausible, recognizing the relevant information that the man is a dwarf is more important (Eysenck, 1966, p. 10).

The second question requires the students to visualize themselves in the situation. Many students used familiar surroundings and visually rehearsed the situation. They saw the house, then the sun, then the boy and finally arrived at the correct answer: north. Others drew maps, sketched the scene or physically walked through the scene. Another student set up a numbering system and counted his way through the problem.

Students usually solved the third question by internal representations but sometimes they drew figures to verify that Tom was shorter than Harry.

I call this classroom exercise "experiencing the image." Experiencing the image has important implications for instructional design. "Experiencing the image" is the process of using images of the mind to solve problems and illustrate information and to practice behavior prior to the actual event. The process includes both the internal representations that we make in our minds and the external representations that we share with others. I believe that instructional designers can use experiencing the image with clients, teachers and students to help them design better curriculum products. By visualizing the problems, material and content that the subject expert brings, the intructional designer can experience the images that the material evokes and share that experience with the intended audience. Better still, the instructional designer can involve students or members of the intended audience in sharing their understandings and internal and external representations when confronted with the subject content. This process can help the instructional designer make decisions about the best way to design the materials. Through awareness, training and practice, students who wish to become instructional designers can learn to experience the image and to externalize their thought processes. If thought processes can be shared though instructional materials, then learning how to learn becomes as important in instructional design as learning the subject content. Thus the instructional design concept becomes a learning process in itself with everyone participating. By exchanging knowledge about (1) how we solve problems, (2) how we think or (3) how we use mental imagery, teachers, educational technologists and students can develop more fully their skills of thinking. By remembering our internal representations and sharing that imagery though our external representations, we can learn the skills of thinking from one another. The external representations thus become the products of instructional design.

In the past few years researchers have given us considerable information on problem solving and creative thinking skills, including many books on these subjects (Hunt, 1982, Taylor, 1982; Van Gundy, 1982; Sommer, 1978; Hayes, 1981). Also, research on mental processing, aptitude treatment interaction and instructional design as it relates to theories and principles of learning is becoming increasingly important in educational technology research and theory (Bovy, 1981; Gagne, 1980; Snow, 1980; Salomon, 1979).

My research does not concern itself directly with mental processing, aptitudes, or instructional methods, rather I am interested in developing some instruments to encourage students to visualize information given to them and use these instruments for internally and externally representing their thinking in order to solve problems. I am more concerned with demonstrating the potential of visualization at a pragmatic level in terms of instructional design than in looking at the actual cognitive processing studies currently popular in educational technology (Bovy, 1981).

Let me make the following observations. Obviously, intellectual processes (insight, verbalization, introspection, prior knowledge and reflection) are difficult to measure even through intensive interviewing or highly controlled experiments. However, researchers have measured whether or not a person has a certain aptitude for solving problems. We know that with prior experience or proper training a person can transfer previously acquired thinking to other similar problems. Also, research on attention, memory and cognition suggests that learners with low levels of experience, knowledge or aptitude require more external instructional help (Bovy, 1981, p. 215). I am interested in demonstrating to students that visualization is an alternative way of thinking that is not commonly used in our educational system and not emphasized by instructional designers in their models.

I feel that students of media who are interested in instructional design should practice the process of visualization that many questions require. There are many models for instructional development available to students of educational technology (Gustafson, 1981). Instructional designers need to externalize their internal representations in order that the products of instructional design become the fulcrum of the learning process. If we can get instructional designers first to visualize their thinking and learning experiences and secondly to make external representations of this process, then we can truly involve the educational technologist in the learning process. More importantly, the instructional technologist as a practitionor or researcher can involve the content specialists and learners in the instructional design of curriculum as well. Consequently, the learner becomes a participant in the design of materials that are to be used to communicate ideas, facts, knowledge, and values to the learner himself and the learner's peers. This participatory approach to the design of instruction thus includes the teachers, students and instructional designers. The content, values and experiences can be shared and communicated in a collaborative fashion. Finally, the participants begin to learn how each thinks and thus share, develop, and learn the processes of thinking.

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PATTERNS FOR MAPPING COGNITIVE STRUCTURE

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Constructive Design Models

The revolution in learning psychology begun by Bartlett (1932) has vaulted cognitive theory to preeminence in the field. Aided by Piaget and other constructive theorists, cognitive theory assumes that knowing is a process of individually constructing our own models of reality. Individual constructions of knowledge result in a network of constructs (referred to as cognitive structure) which are heterarchically related.

Instructional design theory has only recently begun to asssimilate the constructive principles of cognitive psychology into it's definition and processes. Winn's "open system model of learning" (1975) asserted that learning is the modification of one's cognitive structure through experience. The implications of cognitive psychology for instructional design suggest among other things that instruction must relate both the content and the structure of content to be stored in memory with that which is already stored (Low, 1980). More specifically, constructivistic conceptions of the design process (Wildman, 1981; Wildman & Burton, 1981) assume that the purpose of instruction is to replicate the content structure of knowledge in the cognitive structures of learners by specifying the information processing tasks associated with the construction of appropriate knowledge structures. Instruction is the control of cognitive processes (Winn, 1982). What is needed is a set of processes for implementing these conceptions into the design science of instruction. Design strategies intended to accomodate some of these changes in thinking have been proposed (Bell, 1981), yet more fundamental procedures need to be developed, eg. how do we assess cognitive structure? Before we can assess changes in cognitive structure or mediate that change, we first need to develop methods for identifying what an individual's cognitive structure looks like, that is, what someone already knows (prior knowledge).

Prior Knowledge

That prior know ledge is a strong predictor of learning is both intuitively and empirically obvious. Learners without adequate prior knowledge structures require comensurately more instructional support in order to accomplish an objective (Tobias, 1976, 1978; Tobias & Redfield, 1980). In most of the studies reviewed, prior knowledge is measured by some form of pretest which is then regressed on posttest scores. Pretests are most often criterion-referenced to the posttest mental behavior. While this approach is useful for research, its linear, uni-dimensional conception of prior learning does not provide an adequate description of someone knows about a subject. Aquiring, organizing, and retrieving knowledge requires several levels and types of prior knowledge -- superordinate, coordinate, subordinate, analogical, and arbitrary ideas, as well as appropriate cognitive strategies for connecting the ideas (Reigeluth, 1980). In order to accurately depict the complexity of prior knowledge, a more constructivistic conception should be adopted. If learning is to be described as the modification or growth of cognitive structure (Wildman, 1981; Winn, 1982), then the means for describing an individual's knowledge structure is needed.

Pattern Notes

If we accept that the organization of ideas in memory represent a network of interrelated and integrated concepts, then our organizational devices (notes, outlines, etc.) and other word relations should be similarly structured (Buzan, 1974). Pattern notes (or "brain patterns" as Buzan referred to them) do just that (see example in Figure 1). They organize material in a relational manner, showing linkages between topics (Fields, 1980, 1982). Pattern notes can best be described as a spatial word associtition task, with each idea linked by lines (representing relationships) to a central idea and to each other. The working hypothesis of this study is that pattern notes represent an efficient methods for manifesting the cognitive structure of individuals.

To construct a pattern note, you first identify your primary subject, write it in block letters in the center of a blank sheet of paper, and box it. Next you free associate about the subject, thinking about the key issues. Additional association should generate subsumptive ideas about those secondary ideas, and so on until the subject is sufficiently elaborated. Finally, lines may be drawn between some of the secondary/teriary ideas, connecting them together in a network, in the way that "relational links" is related to "authors subject knowledge" in the pattern note in Figure 1 (a pattern note about pattern notes, Fields, 1982). The technique is simple to learn for all ages of students. It provides an excellent mechanism for notetaking, organizing speeches and papers, studying for an exam, and so on.

OVERVIEW OF STUDY

Purpose of Study

Since pattern notes depict the relationships between concepts associated with each other, it is reasonable to suppose that they may be able to adequately manifest cognitive structure. Since the technique is easy to learn, pattern notes could provide an efficient means for assessing the complexity of a student's prior knowledge about a subject. More importantly, we could quickly become aware of the idiosyncratic way that each learner relates importantconcepts to each other, a potentially powerful design/evaluation tool.

Methodology

So, in this study students were first administered a classic word association task, using as stimulus words the fourteen most commonly occurring terms related to Newtonian mechanics (Johnson, 1967) -- time, speed, force, mass, momentum, etc. Based upon a comparison of methods, Preece (1976) concluded that the "word association test was a particularly valuable device for mapping cognitive structure if associations were constrained to the particular semantic domain involved" (p.7). It provided the best model of content structure as manifest in the cognitive structure of learners. The degree of relatedness between each pair of words was calculated and mapped using a multidimensional scaling procedure.

After an hour an a half of instruction on how to construct pattern notes, students were required to construct notes using each of the same fourteen words as the keyword that were given in the word association task. The patterns were considered digraphs (Harary, Norman, & Cartright, 1976) and the distances between each pair calculated. These distances were also scaled.

Hypothesis

The purpose of the study was to see if the structure of physics concepts manifest by the distances in the pattern notes was similar to that manifest by the semantic distances produced by the word association task. If the underlying structure was the same, as expected, then pattern notes should be able to provide an efficient means for mapping cognitive structure.

METHOD

Participants

High school students enrolled in two sections of a physics course taught at a suburban high school in the southeastern United States agreed to participate. Prior to the study, they had been taught all of the concepts employed in the study, ie. they each should have had a well developed cognitive structure related to Newtonian physics. As this was an advanced, elective science course, all students were intellectually capable and motivated. All procedures in the study were conducted during their normal class time, the first two periods of the school day.

Instrumentation

Word Association Test. The fourteen stimulus words used in the study were identified by Johnson(1967) as representing the core concepts of the highly structured subject of Newtonian mechanics. Each of the words was printed at the top of a separate page, and beneath it were 17 horizontal lines. The stimulus word appeared to the left of each line. The test contained one page of instructions, including an example, and 14 pages for responses, similar to that described by Shavelson(1974). The order of concepts in each test was randomized for each student. They were instructed to write as many words related to each of the 14 stimulus words as they could think of. They were instructed to "think like physicists" when completing the task, in order to "constrain their associations to the semantic domain." One minute was allowed for each concept.

Pattern Construction Test. The same 14 stimulus words were used in the pattern noting test. Each word was hand lettered in block caps (approximately 18 point) horizontally in the center of a blank sheet of paper. A box was drawn around each word. The one page of instructions (no example provided) directed students to construct pattern notes for each concept on each page. An example of a student's response is illustrated in Figure 2. The order of concepts presented was randomized for each student. One minute and ten seconds was allowed for the construction of each pattern (additional time provided for drawing). In both the Word Association and the Pattern Construction Tests, students were instructed in the directions to "think like a physicist" when responding to the tasks.

Procedures

The study was carried out over a three-day period. On the first day, the word association test was administered. The students were instructed that this test was part of a study to find out how we learn concepts in physics and how teachers can learn to teach better.

The following week, the second day of the study included instruction and practice in preparing pattern notes. The students were presented with a mock problem in which linear notes are inadequate, and then shown how to prepare pattern notes. The students practiced by preparing pattern notes on three separate topics . These results were shared. A homework assignment to construct pattern notes on two additional subjects was given. The next day, these patterns were checked to insure that each student understood the technique, and the results were shared with the rest of the class. The application of pattern notes was discussed. Finally, the Pattern Construction Test was administered. Students were thanked for their participation.

RESULTS AND DISCUSSION

Analysis was completed for 24 subjects randomly selected from both classes of students.

Analysis of Word Association Test

The degree of semantic relatedness of each of the 14 concepts to each other was determined in order to assesseach student's underlying cognitive structure related to Newtonian physics. The relatedness coefficient (Garskoff & Houston, 1963) used response frequencies and relative rankings of word distributions between pairs of stimulus words to determine the relatedness of two concepts.

Based upon these assumptions:

- Relatedness of words varies with the degree to which their associative hierarchies are identical.
- Words may have different independent relations to each other that contribute to their relatedness.

- General level of verbal relatedness, regardless of kinds of relationships between words, can be measured.
- The order of appearance in each associative hierarchy reflects the psychological importance of a word (ie. first emitted associates have more meaning).

Garskoff and Houston (1963) derived a formula for the relatedness coefficient:

$$RC= \frac{\bar{A} \cdot \bar{B}}{(A\cdot B) - n^{p} - (n-1)^{p}\ 2}$$

where:

- $\bar{A}$ and $\bar{B}$ are the rank orders of words under A that are shared with B, and vice versa.
- $A\cdot B$ represents the rank order of A times the rank order of B (all values times itself)
- n represents the number of words in the longer list
- p represents a probability weight that can be applied to different parts of the distribution; $p=1$ was used in this study to give equal weight to all portions of each distribution.

Simply stated, RC represents the amount of obtained overlap between two lists divided by the maximum possible overlap. If each list were identical (which they couldn't be because the stimulus word at the top differs with each list), RC would equal one. Relatedness coefficients were calculated for each pair of words (91) for each subject. A matrix was developed for each subject which represented the relationships, in terms of semantic distance, among these physics concepts in memory. That is, the matrix represented an individual's map of that part of their cognitive structure. Table 1 contains the mean relatedness coefficients for the Word Association Test. The lower the relatedness coefficient, the less is the overlap between the concept pair, ie, they are less related. The relatedness coefficients show fairly strong interrelationships between most concepts, consistent with the very tight content structure of the subject. High relatedness coefficients between pairs such as *mass-weight* or *speed- accelration* indicate the stronger relationships typically ascribed to them.

Non-metric multidimensional scaling (MDS) was used to map the distances between the concpets. MDS analyzes proximity data (degree of similarity between objects) producing a *configuration of points* that spatially represent the similarity between all the stimulus values (Kruskal & Wish, 1978). Similar objects cluster together; dissimilar are further apart.

Relatedness coefficient matrices were considered similarity matrices and scaled using the program ALSCAL (Young & Lewyckyj, 1979). Non-metric analysis of this interval data was mandated by the program's use of the SIMILAR option, since ALSCAL is set up to analyze dissimilarities, and the relatedness coeeficients were similarity-type. Rather than using median values of the coefficients to create a single matrix for scaling (Shavleson, 1972), an individual differences model (INDSCAL) was used to analyze individual matrices of coefficients (Carroll & Chang, 1970).

A three-dimensional scaling solution is plotted in Figure 3. The configuration did not match the data very well (stress=.20 averaged over the matrices, which tends to increase stress), however very explicable clusters of concepts emerged from the analysis. The concepts of *speed, velocity, acceleration* were clusterd in all three dimensions. The concept *time* was usually at the fringe of that cluster, frequently associated with the concept, *work* (a non-physics oriented association). Weight-mass were also always closely related. The concept inertia was usually isolated, consistent with Shavelson's (1972) results. Power, force, energy were more loosely clustered on most dimensions, which is consistent with the content structure.

Analysis of Pattern Construction Test

An initial assumption of this analysis called for treating the pattern notes as digraphs (directed graphs). Digraphs represent an axiom system which contains a finite set of points and lines (none of which are parallel) and a set of functions whose domain is defined by the lines and whose range is defined by the points (Harary, Norman & Cartwright, 1965). These combine to form a spatial representation of a network of nodes (ideas, roles, operations, etc.). Digraphs can be used to describe semantic domains. A digraph describing the structure of mechanics (Preece, 1976) is illustrated in Figure 4. Digraphs may be represented by matrices, the vertices of which quantitatively represent the lines of a digraph.

So, in this study, each pattern was considered a digraph, and a preliminary distance matrix, adapted from Shavelson (1971), was formed for each set of patterns for each subject. The distance between two concepts on the pattern, if treated like a digraph is "the number of lines in the shortest path connecting the two points. Pairwise distances between distances on a digraph may be summarized in a distance matrix (Shavleson, 1971, p. 38).

The matrix was formed by counting the intervening lines or connectors between each of the 14 concepts appearing on each of of the 14 patterns. For instance, $d_{velocity\text{-}momentum}=2$ in Figure 2 and $d_{velocity\text{-}force}=3$. These values were collected in a matrix of distances. For each pair with more than one distance value in the matrix, distance was determined by the modal score. When no clear modal score existed, a mean score was calculated. This was done for less than 10% of the pairs in all 24 of the distance matrices. For purposes of subsequent analysis, when no value was present (ie, no pairwise connection made in any of an individual's patterns) the distance value of 7, just slightly greater that the highest value recorded on any of the patterns, was assigned to that vertex (Young, 1982). The mean values for each pairwise comparison across subjects is presented in Table 2. The higher the values presented, the greater was the spatial distance between those concepts as presented on the patterns. Mass-weight, for instance, were closely related while impulse-work were distantly related.

Assuming that pattern notes can be analyzed like directed graphs, the pattern notes were first analyzed using procedures Shavelson (1972) used to analyze content structure. So, an adjacency matrix was formed for each individual's set of patterns. An entry, $a_{ij}=1$ is made for a pair if a line connected them on one of the patterns. The value of 0 was entered on the matrix if they were not anywhere connected. A distance matrix was formed by converting the adjacency matrix using procedures described by Harary, Norman, and Cartwright (1965, pp. 135-136). A matrix multiplication/distance matrix construction algorithm was written for a microcomputer and the distance matrices formed.

This method of analysis was rejected because the resultant distance matrices were too tight and not at all consistent with those reported by Shavelson (1971). The greatest distance between any pair of concepts was two, which is dissonant with every measure of that content.

A major deficiency of this procedure may be related to an assumption about digraphs. One of the fundamental differences between pattern notes and digraphs is that the former does not indicate directionality. That is, the propositional relationships between nodes on a digraph are signaled by arrows to indicate the relationship of one to the other. While these relationships may be symmetric, ie. two-way, no indication of directionality is indicated on pattern notes. The relationship between concepts, as labelled on each line, is merely associative. This associativity implies symmetric relationships between adjacent concepts on the pattern. Thus, no distinction is made between indegree (number of lines on a digraph directed to that node) and outdegree (number of lines from a particular node). Only total degree, number of lines connected to a concept) is of concern. This symmetry yields only a half-matrix of values (distances) between each of the fourteen concepts, which means that no conversion of from assymetric-to-symmetric was necessary to equate it with the symmetric relatedness coefficient matrix, as was necessary in the Shavelson (1972) study. This compromise, added to the high proportion of adjacent concept pairs reported on at least one pattern produced by each student, resulted in an inordinately tight distance matrix. So, the Euclidian distances between concepts on each pattern were determined.

The distance matrices for each subject were also mapped using the same MDS procedure used with the relatedness coeeficient matrices, with the exception of the SIMILAR option. An individual differences model was employed to analyze the dissimilarity-type distance scores. Rather than transforming the data to similarity-type as Shavelson (1972) did, the default value (dissimilarity) of the scaling program was used to map the values.

A two-dimensional solution (see Figure 5) resulted. Goodness-of-fit was again not good (stress=.22 averaged over the matrices), again an artifact of the individual differences model. Only 73% of the variance was accounted for by the solution, indicating that other individual differences (eg. spatial ability, ideational fluency, crystallized or fluid intellegence) accounted for the remainder. Since stress increased for the three-dimensional model, the two-dimensional solution was accepted. Similar clusters appeared in the pattern note map, however. Velocity, speed, and distance were closely related with acceleration and time more distant outliers of of that cluster. The mass-weight combination was still tight. Inertia and impulse were still isolated, and power, work, force, and energy were still loosely clustered.

The Correspondence Between Word Association and Pattern Note Structures

Correlation. Two **analyses** compared the relatedness coefficients and distance values for the matrices of concepts-- correlation analysis and multi-dimensional scaling. Pearson correlation coefficients were calculated for the corresponding vertices of the relatedness coefficient and pattern distance matrices (see Table 3). All coefficients were negative, since similarity (relatedness) data was being compared with dissimilarity (distance) data. A minority (20%) of the coefficients reached statistical significance. Had the number of subjects been greater than 24, a larger proportion of the coefficients would have reached significance.

The largest proportion of significant correlations occurred between concepts that generally produced the lowest frequency of responses. It might be expected that *mass*-*weight* and *speed-velocity* , because of their high degree of semantic relatedness, would result in the greatest consistency between pattern and word tasks. However, those correlations were generally low ($r \leq .10$), with the highest correlation coefficients occuring for the more isolated of the concepts -- *momentum*, *inertia*, and *impulse*. It was that lack of response however that produced the higher correlations. Those concepts generally had the lowest relatedness coefficients and the highest distances between pairs. While there appeared to be a substantial amount of correlation between the relatedness coefficient and distance matrices, it is clear that individual differences also accounted for a great deal of the variance.

Comparison of MDS Solutions

Since the hypothesis of this study was that patterns can map cognitive structure, the most important comparison is structural, ie. do the scaling solutions produce similar semantic maps or domains? The clusters produced by scaling the relatedness coefficients and the distances between concepts are very similar. Compare, for instance, the Dimension I-II graph in Figure 3 (relatedness coefficients) with the two-dimensional graph in Figure 5 (distances). Not only are the clusters the same but their positions relative to the graph are very similar. No rotation of the abscissa and ordinate (a common practice in interpreting MDS solutions) was necessary to manifest the similarity. The overall semantic structure produced by the distance between concepts on the pattern notes is very similar to the structure produced by the relatedness coefficients derived from the word association task (the best existing measure of cognitive structure). Pattern notes can, to the degree of accuracy represented by this study, represent cognitive structure. This conclusion is tempered by the lack of perfect fit produced by either MDS solution. A good deal of variance is not accounted for in either map. However, the remarkable similarity in the spatial relationships between concepts manifest by both solutions indicates at least a good approximation of cognitive structure produced by the pattern notes.

Implications for Instructional Design

If further research can cooroborate the tentative conclusions of this study, designers and teachers may have a powerful teaching and assessment tool. Individual differences in cognitive structure resulting from prior exposure to instruction is a strong predictor of learning this subject matter (accounting for 35% of variance), so tracing the development of an individual's cognitive structure and matching it to content would increase comprehension and understanding (Thro, 1978). Based upon the general findings of this study, that pattern notes reflect the cognitive structure of individuals, several specific applications of pattern notes to instructional design activities are suggested:

- Means for assessing prior lnowledge. The complexity of prior knowledge could be more accurately represented by a pattern than by a pretest.

- Diagnostic tool. To ascertain the extent of a learner's knowledge with regard to a subject should enable you to determine at what task level to begin.

- Remediation. Interpreting posttest results could be facilitated by patterns, by determining "where the learner went wrong" is a variation on the evaluation theme.

- Mediator for instruction. Knowing the associations that someone makes relative to a subject would provide the designer with the anchoring points for relating new information, ie. customizing comparative organizers.

- Organizers. Using content structure patterns (maps), overtly instruct learners about the relationships between concepts related to the subject. Used in conjunction with the first two suggestions, do spatial comparisons with the learner.

- Task analysis. If cognitive theory is assimilated by instructional developers, the most radical change needs to occur in the nature of task analysis. Using Winn's (1978) expanded conception of task analysis, patterns could provide both a rational and empirical outcome of a structural analysis process, ie. determining the structure of the content and the knowledge of the learners.

If further research corroborates the validity and reliability of pattern notes as a measure of cognitive structure, teachers and designers may have available, with little effort, a rich diagnostic and instructional tool.

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TABLE 1

Mean Relatedness Coefficients for Word Association Data

Stimulus Words	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Momentum													
2. Inertia	24												
3. Power	18	11											
4. Mass	42	21	09										
5. Time	26	13	11	12									
6. Work	18	12	28	14	10								
7. Weight	31	26	17	57	17	12							
8. Acceleration	42	21	15	30	32	23	25						
9. Force	36	26	30	31	23	29	37	29					
10. Distance	24	14	09	13	37	17	14	35	21				
11. Velocity	42	19	14	23	39	15	21	57	31	42			
12. Impulse	35	17	16	19	23	19	21	23	27	23	24		
13. Speed	35	16	13	26	34	16	27	52	31	44	61	24	
14. Energy	15	13	41	08	10	24	08	12	23	10	11	12	08

Note: Decimals before each value omitted.

TABLE 2

Mean Distances Between
Concepts on Pattern Data

Stimulus Words	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Momentum													
2. Inertia	48												
3. Power	53	64											
4. Mass	27	40	50										
5. Time	38	57	51	43									
6. Work	58	67	48	53	48								
7. Weight	41	49	59	16	48	57							
8. Acceleration	35	52	53	31	26	59	42						
9. Force	26	35	34	24	34	38	28	34					
10. Distance	43	58	58	38	24	61	46	32	49				
11. Velocity	24	50	57	32	26	57	39	18	28	29			
12. Impulse	41	62	55	43	44	60	55	58	42	55	44		
13. Speed	26	54	57	34	24	57	43	23	31	24	17	50	
14. Energy	51	53	31	43	48	40	51	58	34	60	50	58	59

Note: Decimals omitted. Values should have decimal inserted between numerals, eg. 3.2 .

TABLE 3

Pearson Correlation Coefficients for Pairwise Comparison of Relatedness Coefficients and Distances

Stimulus Words	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Momentum													
2. Inertia	36												
3. Power	10	03											
4. Mass	34	06	16										
5. Time	51	28	33	44									
6. Work	59	14	53	36	24								
7. Weight	25	02	20	04	54	18							
8. Acceleration	49	67	23	52	21	24	37						
9. Force	11	15	26	13	07	52	10	29					
10. Distance	58	16	35	31	17	27	39	08	11				
11. Velocity	12	39	12	21	41	37	24	22	26	01			
12. Impulse	69	58	28	35	29	16	03	64	23	29	43		
13. Speed	41	34	24	31	05	49	34	15	29	01	12	21	
14 Energy	16	09	12	20	39	60	13	07	09	24	04	57	12

Note: All values are negative; decimal points omitted, underlined values, $p < .05$

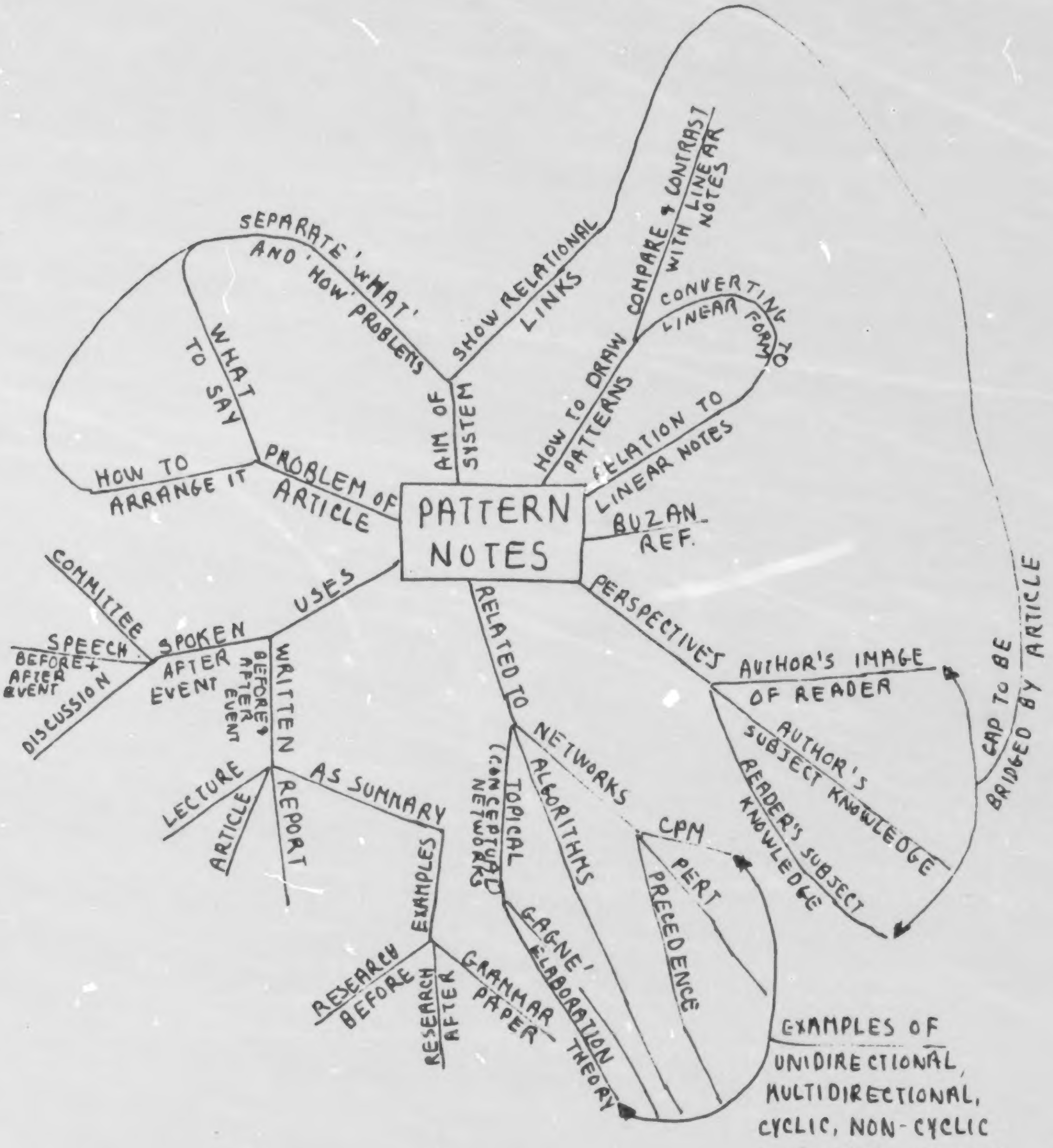
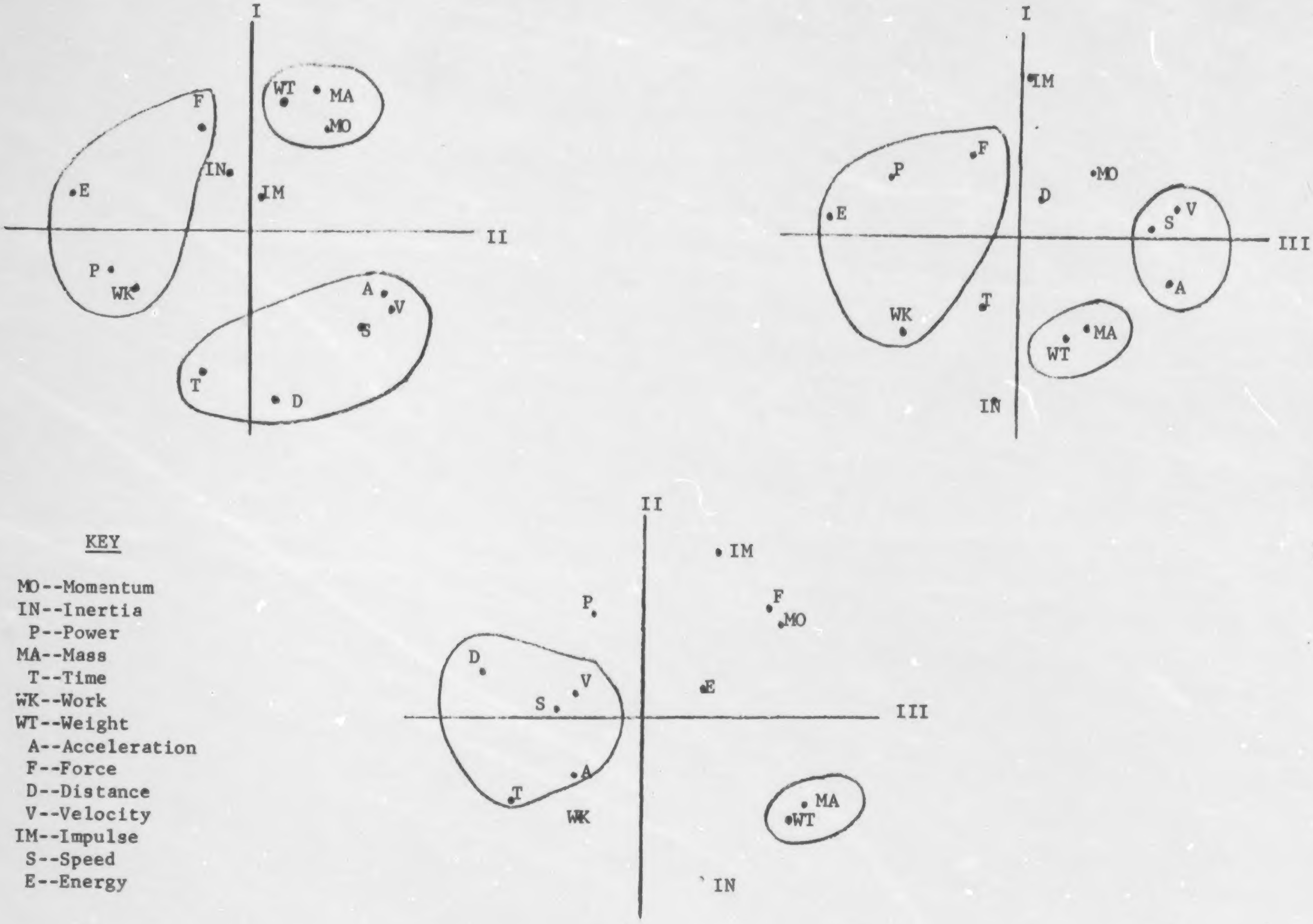

PATTERN NOTES
AIM OF SYSTEM
SHOW RELATIONAL LINKS
COMPARE + CONTRAST WITH LINEAR NOTES
HOW TO DRAW PATTERNS
CONVERTING TO LINEAR FORM
RELATION TO LINEAR NOTES
BUZAN REF.
PERSPECTIVES
AUTHOR'S IMAGE OF READER
AUTHOR'S SUBJECT KNOWLEDGE
READER'S SUBJECT KNOWLEDGE
GAP TO BE BRIDGED BY ARTICLE
RELATED TO
NETWORKS
CPM
PERT
PRECEDENCE
ALGORITHMS
TOPICAL
(CONCEPTUAL NETWORKS)
GAGNE'
ELABORATION THEORY
EXAMPLES OF UNIDIRECTIONAL, MULTIDIRECTIONAL, CYCLIC, NON-CYCLIC RELATIONAL PATTERNS
PROBLEM OF ARTICLE
WHAT TO SAY
HOW TO ARRANGE IT
SEPARATE 'WHAT' AND 'HOW' PROBLEMS
USES
SPOKEN
COMMITTEE
SPEECH
BEFORE + AFTER EVENT
DISCUSSION
AFTER EVENT
WRITTEN
BEFORE + AFTER EVENT
LECTURE
ARTICLE
REPORT
AS SUMMARY
EXAMPLES
RESEARCH BEFORE
RESEARCH AFTER
GRAMMAR PAPER

Figure 1. Pattern notes of an article.



KEY

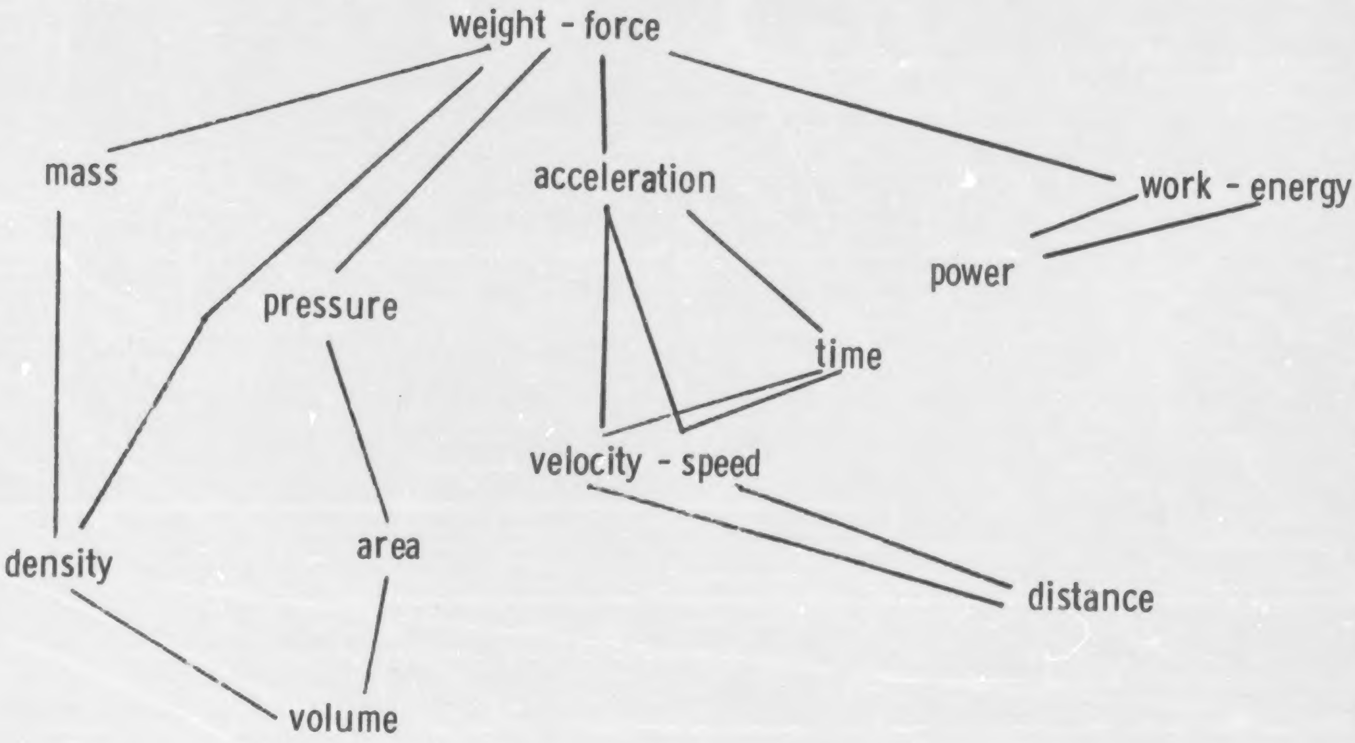
MO--Momentum
IN--Inertia
P--Power
MA--Mass
T--Time
WK--Work
WT--Weight
A--Acceleration
F--Force
D--Distance
V--Velocity
IM--Impulse
S--Speed
E--Energy

FIGURE 3

Three-Dimensional Multidimensional Scaling Solution for Relatedness Coefficient Matrices

Figure 4

Digraph Model of Cognitive Structure
(Preece, 1976)


weight - force
mass
acceleration
work - energy
power
pressure
time
velocity - speed
density
area
distance
volume

KEY

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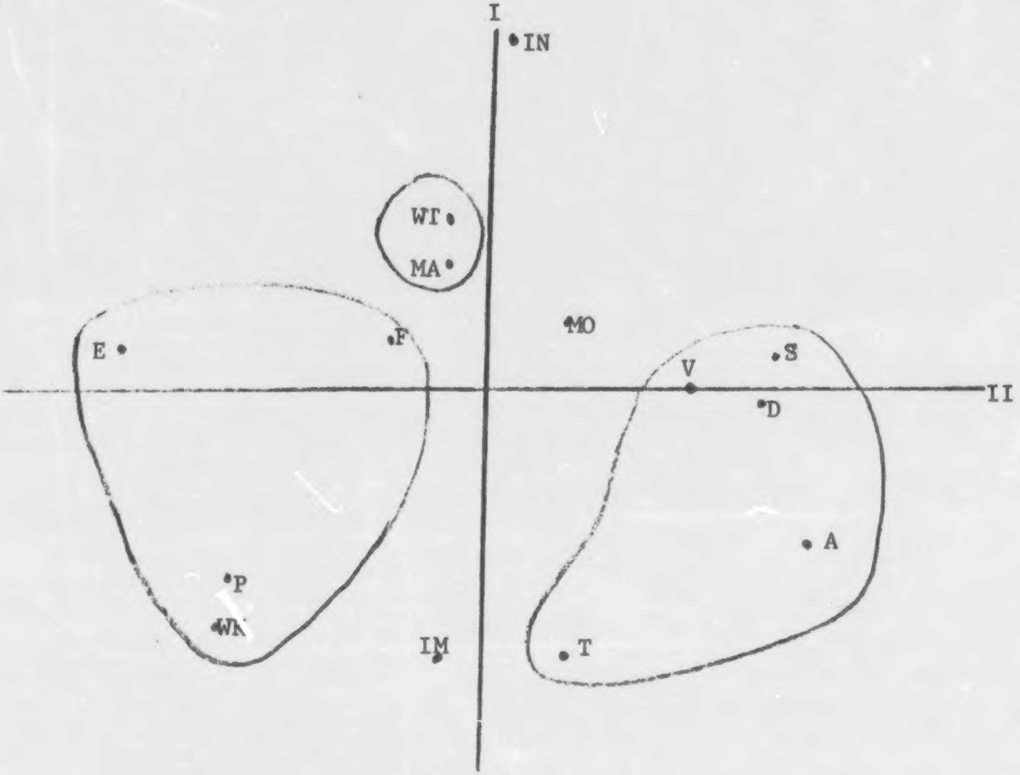

FIGURE 5

Two-Dimensional Multidimensional Scaling Solution
for Pattern Note Distance Matrices

TITLE: The Effects of Reading Ability, Presentation Mode and the Integration of Abstract and Realistic Visualization on Student Achievement

AUTHOR: John H. Joseph

The Effects of Reading Ability, Presentation Mode and The Integration of Abstract and Realistic Visualization on Student Achievement

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Paper Presented at the 1983 Annual Convention
Association for Educational Communication and Technology
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Purpose

This study examines the effect of the level of reading ability on the instructional effectiveness of different types of illustrations which accompany two modes of instruction. Of particular interest are illustrations which integrate abstract and realistic visualization.

The relative effectiveness of abstract and realistic visualization remains of interest. A general preference for realism is reinforced by several early theories which Dwyer (1972) refers to as "realism theories." The preference for complex detailed illustrations, particularly by older children and adults was found by a number of early researchers (French, 1952; Spaulding, 1955). Also, Yarbus (1967), Kahneman (1973), and Haber (1973) cite evidence that complexity is a major determinant of attention.

Other theorists argue that an increase in realism will not necessarily lead to increased learning. Dwyer refers to these positions as "irrelevant cue" theories. Hochberg (1962), for example, suggests that "the characteristics of a given object may be communicated better as the representational fidelity of the surrogate deteriorates." Dwyer found that the type of visual illustration (abstract vs. realistic) which was most effective for instruction was dependent upon the kind of instructional objective, whether the instruction was self-paced or externally-paced, the grade level, the level of entering behavior (prior knowledge), and the level of general ability.

Joseph (1978) found that the inclusion of realistic visualization improved instructional effectiveness under general conditions. The effectiveness of abstract visualization was found to be dependent on pacing (external vs. internal), general ability, and the type of instructional objective. Integration of abstract and realistic visualization was found to improve effectiveness for externally-paced instruction under certain conditions.

The processes of perceptual learning which are involved in reading also apply to the extraction of information from visual illustrations. Similarly, cognitive strategies utilized in reading are utilized in learning from visuals. Robeck and Wilson (1974) and Gibson and Levin (1975) discuss evidence that good and poor readers are affected in different ways by irrelevant cues present in stimulus materials. Dechant and Smith (1977) cite research suggesting a relationship between the level of reading ability and the ability to form concepts from abstract and concrete stimuli.

The purpose of this study was to investigate the instructional effectiveness of illustrations which integrate abstract and realistic visualization for students of different reading abilities. Two methods of integrating the visualization were investigated. The first was with a hybrid illustration, a real color photograph into which a line drawing segement has been inserted. This provided an abstract illustration of the important relevant elements to be communicated, as well as a realistic context. The second method was through the simultaneous presentation of both a line drawing and a real color photograph. In this treatment the abstract line drawing could communicate the essential information and/or influence selective attention in looking at the realistic illustration. The realistic illustration, on the other hand, could motivate and arouse as well as communicate essential information. The effectiveness of these treatments, as well as those of the line drawing alone, the realistic photograph alone, and a control treatment without visuals, was measured

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for five kinds of learning objectives, externally-paced and self-paced methods of instruction, immediate and delayed retention, and three levels of reading ability.

Procedure

Subjects were 374 tenth grade public school students enrolled in mandatory health education classes. Classes were coeducational and there was no ability grouping.

The subjects were stratified into three groups in the basis of their reading ability scores from the Metropolitan Achievement Tests, Advanced form. The authors report the reliability (Kuder-Richardson 20) of this 45-item subtest to be .93. The test measures vocabulary and word recognition as well as paragraph plus larger selection comprehension. Bartlett's test was used to test the homogeneity of variance in the reading ability scores for the ten treatment groups. A one-way analysis of variance also was performed for these scores in the ten treatment groups. Both tests were nonsignificant at the .05 level.

A 36-item physiology pretest, the same instrument used by Dwyer (1972), was administered to all subjects prior to instruction. The Bartlett's test and analysis of variance of these scores indicated that the treatment groups had homogeneous variances and no significant differences in prior knowledge related to the instructional unit.

The instructional unit and criterion tests were those developed and used by Dwyer (1972). The 2,000 word instructional script deals with the construction and operation of the heart and is accompanied by 37 visuals which illustrate concepts and relationships for which visualization is likely to be beneficial.

The criterion tests were a drawing test with 18 items and identification, terminology and comprehension tests with 20 items each. Together these four tests constituted a total criterion test. Reliabilities (KR-20) of the individual tests equal or exceed .76. The reliability of the total test is .91, according to Dwyer (1972, p. 12).

Half of the subjects received self-paced written instruction and half received instruction by an audio tape recording (with visuals in booklet form for both modes). Within each of these two modes the students received one of the five treatments: instruction with simple line drawings, instruction with realistic color photographs (3X5 inches), instruction with both line drawings and color photographs, instruction with hybrid illustrations composed of realistic photographs with line-drawing segments, and a control group with no visuals. Treatments were randomly assigned to subjects. All students received the four-part criterion test on the day immediately following the instruction and again after two weeks.

The analysis involved a three-factor design denoted RS_n in $(A_5@B_2@C_3)$. Random subjects were nested in cells formed by the three factors:

Factor A: Five levels of the instruction variable, 1) no illustration (control), 2) line drawing, 3) realistic photograph, 4) hybrid illustration and 5) both a line drawing and a realistic photograph.

Factor B: Two levels of the presentation mode variable, 1) externally-paced and, 2) self-paced.

Factor C: Three levels of the learner characteristic variable, 1) low, 2) medium and 3) high reading ability.

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Separate analyses were completed for five levels of the dependent criterion variable: 1) drawing test score, 2) identification test score, 3) terminology test score, 4) the comprehension test score and 5) a total criterion test score which combined the other four scores.

The library program RUMMAGE was used for the analysis of variance procedures. This program will handle balanced and unbalanced experimental designs, missing data and transformations. Cell sizes averaged 10 for the immediate posttest and 11 for the delayed posttest.

Immediate Posttest: Results

Drawing Test

The analysis of variance procedure for the drawing test produced a significant* F value for the AC interaction (type of visualization vs. level of reading ability) and for the B factor (pacing).

Tests of the B means indicated that the externally-paced subjects scored significantly higher than the self-paced subjects.

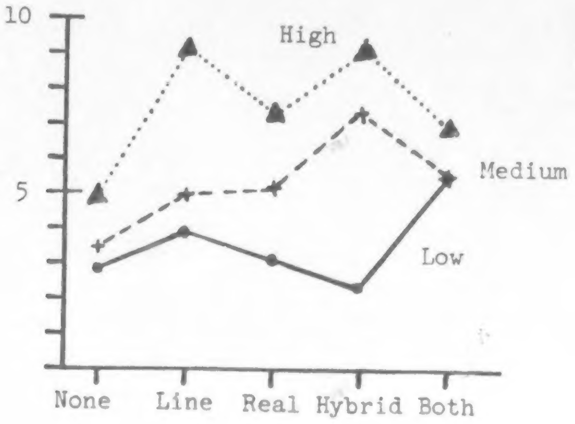

Figure 1. Drawing Test

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* α = .05 for all tests

Figure 1 illustrates the AC means. For the low reading ability group, students receiving the "Both" treatment scored significantly higher than those receiving the hybrid visuals and the control group. In the medium reading ability group, the hybrid visuals were significantly more effective than no visuals, line drawings and realistic photographs. For students in the high reading ability group, the line drawing and hybrid illustration treatments were significantly more effective than the no visual treatment.

Identification Test

The analysis of variance procedure for the identification test produced a significant F value for the B and C main effects.

For the pacing factor (B) the externally-paced group scored significantly higher than the self-paced group. Results for the C factor indicate that high reading ability students received significantly higher scores than low and medium reading ability students.

Terminology Test

Only the reading ability factor (C) produced a significant F ratio in the analysis of variance procedure for the terminology test. For this test the mean of the high level group was significantly higher than that of the low level group.

Comprehension Test

Only the reading ability factor again produced a significant F ratio for the comprehension test. Results of the pair-wise comparisons of means were identical to those for the terminology test above.

Total Test

The analysis of variance procedure for the total scores produced a significant F value for the A and C main effects. The AC interaction and the pacing factor (B) approached significance.

For the treatment factor line drawings and hybrid visuals were significantly more effective than no visuals (control group).

For the reading ability factor, low, medium and high reading ability group scores all differed significantly, each group receiving higher scores, respectively.

Table 1 presents the types of visualization which resulted in the highest achievement on the criterion measures for the immediate posttest. Caution must be exercised in interpretation of this information because the results do not necessarily represent significant differences.

Delayed Posttest: Results

Drawing Test

The analysis of variance procedure for the drawing test produced a significant F value for the B and C main effects.

With respect to the B factor, as in the immediate posttest, externally-paced subjects scored significantly higher than the self-paced subjects.

For the C factor the low, medium and high reading ability groups, respectively, received significantly higher scores.

Identification, Terminology, Comprehension and Total Tests

For the remaining tests in the delayed posttest, only the reading ability factor (C) produced significant F ratios in the analysis of variance procedures. With the exception of the comprehension test, the low, medium and high reading ability groups differed significantly on all tests, with each receiving higher scores, respectively. On the comprehension test, the high reading ability group scored significantly higher than the low and medium reading ability groups.

TABLE 1

TYPE OF VISUALIZATION WHICH RESULTED IN HIGHEST CRITERION TEST SCORE FOR IMMEDIATE POSTTEST

	Externally-Paced			Self-Paced			"A" Main EFFECT (Combined Groups)
	Reading Ability			Reading Ability			
	Low	Medium	High	Low	Medium	High	
Drawing	Line	Hybrid	Hybrid	Both	Hybrid	Line	Hybrid
Identification	Line	Hybrid	Hybrid	Both	Real	Hybrid	Hybrid
Terminology	Line	Hybrid	Hybrid	None	None	Hybrid	Hybrid
Comprehension	Line	Both	Hybrid	None	Real	Real	Real
Total Criterion	Line	Hybrid	Hybrid	Both	Real	Hybrid	Hybrid

None: No Visual (Control Group)
Line: Line Drawing
Real: Realistic Photograph
Hybrid: Hybrid Visual (Realistic Photograph with Line Segment)
Both: Both Line Drawing and Realistic Photograph Presented Together

The A (treatment) factor approached significance (probability =.056) for the total test scores.

Table 2 presents the types of visualization which resulted in the highest achievement on the criterion measures for the delayed posttest. As in the immediate posttest, these results do not necessarily represent significant differences.

Discussion

Only the immediate posttest drawing test produced a significant interaction of interest with respect to reading ability. For that test, high and medium reading ability students benefited most from the hybrid method of integrating abstract and realistic visualization while low reading ability students benefited most from the simultaneous presentation of both real and abstract visuals. For the low ability students, the difference between the two methods was significant. For high reading ability students the line drawing also was significantly more effective than the control condition.

The results suggest that those with poor reading skills benefit most from the availability of the full context of both the line drawing and the real photograph for the kind of learning measured by the drawing test. The fact that the drawing test calls for a reproduction of the line drawing suggests the possibility that, for the poor reader, the complete realistic photograph serves to arouse and sustain attention. Perhaps average and high ability readers do not require the same high level of arousal, as suggested by Robeck and Wilson (1974).

The significant results for the main effect of pacing, in both the drawing and identification tests indicated a general superiority of the externally-paced instruction. This effect endured to the delayed posttest for the drawing test. The effect approached significance for the immediate posttest total test scores as well. It is important to note that externally-paced treatments lasted 27 minutes while the average time for self-paced subjects

TABLE 2

TYPE OF VISUALIZATION WHICH RESULTED IN HIGHEST CRITERION TEST SCORE FOR DELAYED POSTTEST

	Externally-Paced			Self-Paced			"A" Main EFFECT (Combined Groups)
	Reading Ability			Reading Ability			
	Low	Medium	High	Low	Medium	High	
Drawing	Line	Hybrid	Hybrid	Both	Hybrid	Real	Hybrid
Identification	Real	Real	Hybrid	Hybrid	None	Both	Hybrid
Terminology	Line	Hybrid	Real	Real	Real	Both	Both
Comprehension	Line	Both	Line	Line	None	Both	Both
Total Criterion	Line	Hybrid	Hybrid	Both	Real	Both	Hybrid

None: No Visual (Control Group)
Line: Line Drawing
Real: Realistic Photograph
Hybrid: Hybrid Visual (Realistic Photograph with Line Segment)
Both: Both Line Drawing and Realistic Photograph Presented Together

was only 12.3 minutes. This difference in time available for interaction with the content makes interpretation of the significant main effect difficult. Additionally, it is not clear if the effect is due to the locus of pacing or to the interaction of visual and oral communication as compared with visual presentation of both words and pictures.

The results for the immediate posttest total test scores suggest a general superiority for line drawings and for the hybrid method of integrating abstract and realistic visualization. The finding lends limited support to the "irrelevant cue" theories.

Relatedly, it is interesting to note in Table 1 the consistency of results for externally-paced treatments. Without exception, line drawings produced the highest mean scores for low reading ability students while integrated visuals produced the highest results for medium and high ability students. These results suggest further investigation to determine if this pattern would be maintained for a more rapid presentation of the content.

Conclusions

Results of the immediate posttest suggest that designers of visualized instruction should consider the student's level of reading ability in determining the type of visualization to be used for certain instructional objectives. Line drawings and hybrid visuals appear to be the most generally effective methods for short-term retention. The results regarding pacing suggest further investigation.

TITLE: Teaching Coordinate Concepts for Field Independent and Neutral Students: Effects of Three Instructional Strategies

AUTHORS: Mary Rae Joseph
Phyllis LaCroix

Teaching Coordinate Concepts for Field Independent, Dependent and Neutral Students: Effects of Three Instructional Strategies

By

Mary Rae Joseph

Phyllis LaCroix

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ABSTRACT

A 3 x 3 factorial design was used to explore possible relationships between field independence as a cognitive style variable and relevant/irrelevant examples in childrens' concept learning of propaganda techniques. One hundred one sixth graders were classified as relatively field independent, field neutral, or field dependent. Subjects in each cell were randomly assigned to one of the following concept identification treatments: (1) examples only (2) both examples and non-examples (3) non-examples only. All subjects received the same concept identification test. In most cases, the non-examples of one concept were actually examples of another concept presented. Significant main effects were found on the overall composite score, supporting the hypothesis that field independents have superiority in the functioning of the perceptual and cognitive modes. The example only treatment was the most effective method of instruction, regardless of whether the subjects were field dependent, neutral, or independent.

Teaching Coordinate Concepts for Field Independent, Dependent and Neutral Students: Effects of Three Instructional Strategies

Learning involves a change in a person's knowledge or ability to perform some task. In general, research shows taht presenting definitions, example/non-example pairs, and attribute isolation, provides for adequate learning of concepts (Merrill & Tennyson, 1980). In addition, research on the value of pictures for prose learning indicates that pictures facilitate learning when they do not conflict with the prose (Levin & Lesgold, 1978). It appears that Gabis's hypothesis, that useful visuals provide a convenient structure for complex content, supports this conclusion. Therefore, it seems that verbal and visual example/non-example pairs will adequately present concept instruction. Yet, more research is needed to define useful visuals.

Pictorial illustrations included within verbal materials are usually selected according to subjective feelings of the desinger about what is best, availability of raw materials, cost, attractiveness of a finished product and availability of a ready market (Brody, 1980). These criterion are set apart from scientifically chosen visual examples.

If the concept learning theory holds true and if visuals are a powerful tool that aid learning, then, a useful concept lesson would employ visual examples accompanied by non-examples. We hypothesize that in a concept learning treatment (lesson and test), participants will best learn those concepts when the example/non-example format is used. In addition, we hypothsize that the visual scors on this particular treatment will be higher that the verbal scores. On a treatment presenting examples only, lesson and test scores should be poorer, followed by the poorest performances on a treatment containing only non-examples.

The individual difference dimension which may contribute to information regarding the use of examples and non-examples for concept learning is the cognitive style variable of field dependence/independence. Herman Witkin and others have researched this cognitive style for at least thirty years (Witkin, Moore, Goodenough, Cox, 1977). It is the style which is most widely known, the most thoroughly researched, and has reliable instruments to test it. The most commonly used of these instruments is the Embedded Figures Test (EFT), which requires the disembedding of an item from an organized field. The EFT requires the subject to locate simple figures which are embedded in sets of complex geometric patterns. This test assesses the influence of the surrounding environment on perception. The results indicate that low analytic subjects are almost entirely dependent on visual cues (field dependent) while high analytic subjects disregard them (field independent). Field independents experience items as discrete from their background and tend to overcome embeddedness. They perceive things analytically; whereas,field dependents perceive things globally. Most subjects fall somewhere between the two extremes but tend toward one or the other.

Findings show that field independent subjects are superior to field dependent subjects in learing dimensioned and nondimensioned concepts.

This holds true if the conclusion is based on recognition of relevant or positive examples (Nelson & Chavis, 1977). Yet, in a treatment involving instructional material, followed by example and non-example pairs, both classes of learners should learn equally well. This is due to the design of the mixed treatemnt. The lesson provides for a great deal of practice which is what the field dependent learner might need. It should compensate for their difficulty in learning concepts.

Nelson and Chavis also concluded that field neutral or medium analytic subjects are hindered in recognizing positive examples when exposed to both positive and negative examples. They hypothesized that the inclusion of negative examples in a lesson interferes with recognition of positive examples for the field neutral student.

Based on these factors, we hypothesize that field independent and dependent participants will perform equally well on a concept treatment involving examples and non-examples. Field neutral subjects should recognize fewest positive examples in a concept treatment which includes any non-examples; therefore, they would have the poorest score.

Structuring mechanisms identify field independents from dependents. Field independents are better able to disembed a figure from its surrounding field, analyze a field into its component parts, and thereby impose structure on a field when it lacks appartent organization. Field dependent individuals have difficulty performing the tasks necessary to add structure to the field. Instead, they tend to accept the field as it stands, and once they have accepted a frame of reference, they have difficulty in reorganizing the field to accommodate a different structure.

The cognitive restructuring hypothesis was advanced by Witkin and Goodenough (1982). According to their hypothesis, field independent individuals are better than field dependent individuals in the ability to restructure information in a perceptual and cognitive mode. Davis and Cochran (1982) support the restructuring hypothesis with research on encoding and long term memory. They conclude that field independent individuals are more adapatable in dealing with task ambiguity and reorganization of information.

Research continually shows that field independent people seem better able to achieve a different percept when required to do so by situational demands or inner needs, through the restructuring of their initial perceptual experience (Witkin & Goodenough, 1982).

Since organizing learning material can reduce interference and thereby facilitate learning and retention, field independents should be less susceptible to interference effects because of their more active participation in organizing the material (Witkin et al.,1962/1974; Goodenough, 1976). If field independents are less susceptible to interference they should perform better on a concept learning treatment in which all visual samples are non-examples of the concept being presented.

Goodenough (1976) hypothsized that field dependents perform poorer on concept learning tasks since they are dominated by the most salient figures of a stimulus. As a resut they tend to overlook many features of the stimulus complex. This cue salience hypothesis suggests that field dependent and field independent subjects have quite different search strategies. It is logical to assume that Annis's hypothesis (1979) supports this conclusion. She theorized that field independent subjects are more likely to adopt an active hypothesis testing, participant approach to learning. This reflects their greater structuring ability. In contrast, field dependent learners are more likely to adopt a passive, intuitive spectator approach. As a result, field dependents need stronger cues in order to learn a concept.

When distracting cues are included field dependent subjects have a difficult time selectively attending to the relevant cues (Davis & Cochran, 1982). This is supported by Blower's and O'Conner's (1978) selective attention finding. They concluded that field dependents scan more of the visual field but are unable to selectively attend to the relevant parts of the field.

Another supporting finding is that by Avolio, Alexander, Barrett and Sterns, 1979). They concluded that field dependnet subjects make greater errors than field independent subjects in both visual and auditory modes when asked to attend to relevant stimuli included with competing, irrelevant stimuli.

If relevant cues are this powerful and if distracting cues stand in the way of learning for field dependent students, the field dependents should learn less on a concept lesson which contains distracting or irrelevant information. On the same concept lesson, but on a treatment using all relevant examples, field dependents, independents, and field neutral subjects should perform equally well.

In summary, we hypothesize that:

- Field independents will outperform both field neutral and field dependents, overall, due to their superiority in the perceptual and cognitive modes.
- All learners will perform better on a treatment (lesson and test) containg both examples and non-examples. The next highest scores will be on the treatment involving examples only, followed by the treatment consisting of non-examples only.
- Field independnets and dependents will have the smallest difference in learning on the example/non-example treatment since it is the strongest lesson containing support material to increase learning.
- Field neutral learners will perform poorer on a treatment involving positive and negative examples due to the theory set forth by Nelson and Chavis.
- Field independents will perform better than field dependents and field neutral learners on the treatment with all non-examples. This is based on the theories of restructuring and cue salience.
- Field dependents, field neutral, and field independent subjects will perform equally well on the concept lesson with all positive examples. As a result, they will also perform better on the test. This is based on the theory by Nelson and Chavis.

METHOD

Subjects

Subjects were 110 sixth grade students from a public elementary school in Minnesota. Due to adsences, complete data was not available for nine children; therefore, statistics were computed according to results from the remaining 101. Forty percent of the population in attendance are classified as minority group members, including Hispanic, S.E. Asian, Black and Native Americans.

Design

A 3 x 3 factorial design was employed in this study. The first factor, or independent variable was cognitive style. It had three levels: field independence, field neutral and field dependence. The second factor or independent variable was instructional treatment. It had three levels: mixed examples, examples only, and non-examples only. Approximately one third of the subjects in each of the three cognitive style groups was randomly assigned to one of the three treatments.

Instrumentation

To assess field independence, the Group Embedded Figures Test (GEFT) (Witkin, Oltman, Raskin & Karp, 1971) was employed. The test consists of eighteen items. For each item, subjects are asked to locate a hidden figure withing the embedded context of a complex pattern. Each subject's score, then, is the number of correct tracings of simple figures on complex designs. Three sections are included in the timed test but scores on the last two sections only are used.

Performance on the GEFT reflects a tendency, in varying degrees of strength, toward analytical or global functioning.

The norms and reliability estimates reported in the GEFT manual (Witkin, et.al., 1971) are based on college student samples but Lis and Powers (1979), using a sixth grade sample, calculated long term (i.e., 1 year test-retest) coefficients of stability of .80 and .71 for boys and girls, respectively and coefficients of internal consistency ranging from .83 to.98 for boys and girls on the GEFT.

A number of studies have used the GEFT with children (Sherief, 1979; Powers and Lis, 1977). Studies like these have classified as field dependent children with scores ranging from 0 to 9. The range for field independents has been from 10 to 18, with some studies using a greater range than others.

In the study reported here, students scoring between 0 and 6 were classified as relatively field dependent. Children with scores between 7 and 11 were classified as field neutral and those with scores between 12 and 18 were classified as field independent.

Materials

Any person exposed to television, radio, newspaper, magazines, billboards or other method used to present advertisements should also be exposed to propaganda techniques. Thus, the goal of this lesson was to aquaint sixth graders with four of several propaganda techniques: (1) Testimonial (2) Transfer (3) Repetition (4) Bandwagon.

Before designing and developing the lesson, we checked with all five classroom teachaers to ensure that students knew what the word advertising meant and that none knew any propaganda techniques.

For the study, the investigative team developed three versions of the Propaganda Techniques Lesson and one version of the Propaganda Techniques Test.

The packet (lesson and test) were in self instructional workbook format. The reading level of the lesson was eighth grade, according to the "Graph for Estimating Readibility" by Edward Fry.

The general sequence of the lessons included the technique definition, followed by examples and non-examples and then verbal and visual practive items. The manipulated variable was that the visuals for:

- Lesson One included all examples of each propaganda technique presented
- Lesson Two Included both examples and non-examples of each technique
- Lesson Three included all non-examples of each propaganda technique.

During the process of materials development, both a formative evaluation and a field test were conducted. The formative evaluation was conducted by means of one to one tryouts of the Lesson containg both examples and non-examples and the test. Two students enrolled at a different school than the end users,but at the same grade level, completed Lesson Two and the Test. Neither knew what propaganda was or had a previous lesson on it. After completion of both, the investigator discussed with the two students their experience with the materials to determine time required, errors, sources of confusion, degree of difficulty,etc. The Lesson and Test were refined accrding to the feedback given.

The pilot was conducted with sixteen students in the same school as the test group. Once again, Lesson Two was used for the pilot test. The mean score to the Lesson was 65% and the test was 73%. Students were given the Lesson and Test at the same time so the study would proceed uninterupted. The students were instructed to stay seared until told to stop. To ensure that they would remain quiet, a coloring sheet was included as the last page of the packet to keep participants occupied.

Dependent Measures

The post test was used as a dependent measure to test recall and comprehension. Verbal items for the test were developed and visual items selected by the investigative group. For each technique, the test contained:

- Two verbal examples
- Two verbal non-examples
- Two visual examples
- Two visual non-examples

Procedures

The GEFT, all lessons and the tests were administered by one experimenter to assure consistency in procedures. The GEFT was administered in each classroom by the experimenter before the self instructional lessons and tests. Scores from the GEFT can be seen in Figure 1.

Before completing the packet, the students were told they would be using materials designed for a learning experiment by a University of Minnesota graduate student. They were told that their names would not be used when writing about the results, and were given the option not to participate in the study. None of the students requested not to participant. Nearly all children were able to complete the lesson and test within forty-five minutes.

The lessons and the post test were administered to groups that ranged in class size from 16 to 25. The experimenter went to each room, one at a time,to administer the study. The teachers were not present in the rooms; therefore, the experimener did all of the work. The same introduction and instructions were given to each group before the self study packet (lessons and test) were distributed. A coloring sheet was attached to each packet as an assignment for subjects after they finished the lesson and test. This kept them occupied and from disturbing the other students. The coloring sheet was not analyzed as part of the study. The entire study packet included: one form of the lesson, the post test, and a coloring sheet.

The students went through the entire packet, in order, before the assignment was completed.

RESULTS

Distribution of GEFT Scores

The test results of the Groups Embedded Figures Test are shown in figure 1:

Distrubution of GEFT Scores

	n	$\bar{x}$	s.d.
Field Independent (GEFT 0 ≥ 7)	29	14.52	1.95
Field Neutral (GEFT 8 ≥ 10)	38	8.78	1.42
Field Dependent (GEFT 11 ≥ 18)	34	3.61	1.69
Total	101	8.61	4.63

Figure 1

Since previous studies often have used approximately the top third and bottom third of their samples to classify field independents and field dependnets respectively, the distribution was divided roughly into thirds. The neutral group was included as a separate group to compare the performance of its members with those of the two extreme groups. These classifications provided maximum discrimination between the FI and FD subgroups for the analysis fo variance.

Means and Standard Deviations

Means and standard deviations for the three field independence levels and the three lesson versions are shown in Tables 1-6.

Insert Tables 1-6 about here

Analyses of Variance

To address the major hypotheses of this study, six 3 x 3 analyses of variance were conducted using the Statistical Package for the Social Sciences (SPSS). The dependent variables in these analyses were the three lesson scores and the three test scores. The independent variables in these analyses were treatments and level of field independence/field dependence (FI/FD).

Tables 7-12 present the summary data for the six ANOVAs. There were no conditions under which an interaction of variables occurrred. This does not support the hypothesis which states that field dependents should be distracted more by irrelevant or conflicting information.

Insert Tables 7-12 about here

In none of the six ANOVAs was there any indication of treatment effects. The thesis that mixed examples or all examples would be more effective than all non-examples was not supported by this study. Cognitive style was not a factor in the visual lesson, visual test, or verbal lesson. In three of the experimental conditions, however, there are indications of the importance of cognitive style. Cognitive style was a significant variable at the .059 level in the composite lesson (Table 9); at the .012 level in the verbal test (Table 11); and at the .016 level in the composite test (Table 12).

DISCUSSION

This study supports the theory that field independent subjects would perform best in the overall study. Thus, it suggests that these high analytic subjects need fewer examples ot understand a concept.

The reading level of the treatments was at the eighth grade level, two grades above the subjects' educational status. Therefore, another contributing factor for why field independents performed better could be that they function at higher reading levels than neutral or dependent learners.

Also confirmed in this study is that all learners, regardless of cognitive style, performed equally well on the concept treatment containing all positive examples. No negative examples were included that could possibly obstruct learning for field neutral and field dependent learners.

This study does not support the idea that effects would be found between treatments and cognitive styles. This could be due to several reasons. For example, the target group, ahving a high minority population, could have an overall reading level lower than sixth grade. In addition, their cultural background is quite varied form both the visual and verbal examples/non-examples. These two factors lend evidence for the lack of interaction between treatments.

The lessons, besides being at a high reading level, could have needed additional examples/non-examples. Perhaps field dependent and neutral learners need the extra practice to learn a concept.

This could support the theory that field independents need less practice to learn a concept.

A future study might use the same concept and propaganda techniques but:

- Match reading level between target group and concept lesson/test.
- Use examples/non-examples which more broadly fit a diverse culture.
- Provide enough examples and time to allow subjects to learn concepts and complete the lesson.
- Provide feedback throughout the lesson.

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		Treatment 1	Treatment 2	Treatment 3
Field Independent	$\bar{x}$	10.70	10.60	11.11
	s.d.	3.09	2.63	3.1
	n	10	10	9
Neutral	$\bar{x}$	9.85	9.80	9.73
	s.d.	1.72	3.29	2.76
	n	13	10	15
Field Dependent	$\bar{x}$	10.77	9.40	8.64
	s.d.	2.59	1.96	2.2
	n	13	10	11

Table 1
Means and Standard Deviations
for Visual Items Correct* Within Lesson
*Total possible = 16

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		Treatment 1	Treatment 2	Treatment 3
Field Independent	$\bar{x}$	4.80	5.60	5.67
	s.d.	1.75	1.84	1.32
	n	10	10	9
Neutral	$\bar{x}$	4.85	4.90	4.20
	s.d.	1.52	2.02	1.74
	n	13	10	15
Field Dependent	$\bar{x}$	4.69	4.30	4.18
	s.d.	2.39	.82	1.4
	n	13	10	11

Table 2
Means and Standard Deviations
for Verbal Items Correct* Within Lesson
*Total possible = 8

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		Treatment 1	Treatment 2	Treatment 3
Field Independent	$\bar{x}$	15.50	16.20	16.78
	s.d.	4.01	3.91	3.73
	n	10	10	9
Neutral	$\bar{x}$	14.69	14.70	13.93
	s.d.	2.43	4.35	4.04
	n	13	10	15
Field Dependent	$\bar{x}$	15.46	13.70	12.82
	s.d.	3.84	2.21	2.96
	n	13	10	11

Table 3
Means and Standard Deviations for Composite
of Visual and Verbal Items Correct* Within Lesson
*Total Possible = 24

	Treatment 1	Treatment 2	Treatment 3
Field Independent	$\bar{x}$ = 5.90 s.d. = 3.78 n = 10	$\bar{x}$ = 6.70 s.d. = 4.85 n = 10	$\bar{x}$ = 6.22 s.d. = 3.83 n = 9
Neutral	$\bar{x}$ = 4.15 s.d. = 2.67 n = 13	$\bar{x}$ = 6.40 s.d. = 3.6 n = 10	$\bar{x}$ = 5.13 s.d. = 3.62 n = 15
Field Dependent	$\bar{x}$ = 5.15 s.d. = 3.65 n = 13	$\bar{x}$ = 3.60 s.d. = 1.84 n = 10	$\bar{x}$ = 4.36 s.d. = 1.69 n = 11

Table 4
Means and Standard Deviations
for Visual Items Correct* Within Test

*Total possible = 16

	Treatment 1	Treatment 2	Treatment 3
Field Independent	$\bar{x}$ = 6.80 s.d. = 4.26 n = 10	$\bar{x}$ = 8.00 s.d. = 4.85 n = 10	$\bar{x}$ = 8.22 s.d. = 3.83 n = 9
Neutral	$\bar{x}$ = 5.77 s.d. = 3.9 n = 13	$\bar{x}$ = 4.80 s.d. = 4.34 n = 10	$\bar{x}$ = 5.73 s.d. = 4.48 n = 15
Field Dependent	$\bar{x}$ = 6.31 s.d. = 4.77 n = 13	$\bar{x}$ = 4.00 s.d. = 2.11 n = 10	$\bar{x}$ = 3.45 s.d. = 1.51 n = 11

Table 5
Means and Standari Deviations
for Verbal Items Correct* Within Test

*Total possible = 16

	Treatment 1	Treatment 2	Treatment 3
Field Independent	$\bar{x}$ = 12.70 s.d. = 7.96 n = 10	$\bar{x}$ = 14.70 s.d. = 7.09 n = 10	$\bar{x}$ = 14.44 s.d. = 6.4 n = 9
Neutral	$\bar{x}$ = 9.92 s.d. = 6.26 n = 13	$\bar{x}$ = 11.20 s.d. = 7.3 n = 10	$\bar{x}$ = 10.93 s.d. = 7.12 n = 15
Field Dependent	$\bar{x}$ = 11.46 s.d. = 7.76 n = 13	$\bar{x}$ = 7.60 s.d. = 3.47 n = 10	$\bar{x}$ = 7.82 s.d. = 2.86 n = 11

Table 6
Means and Standard Deviations for Composite
of Visual and Verbal Items Correct* Within Test

*Total possible = 32

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	32.034	4	8.009	1.172	.329
Treatment	8.708	2	4.354	.637	.531
Field Independence	23.495	2	11.748	1.719	.185
2-Way Interactions	20.939	4	5.235	.766	.550
A B	20.939	4	5.235	.766	.550
Explained	52.974	8	6.622	.969	.465
Residual	628.868	92	6.836		
Total	681.842	100	6.818		

Table 7
Summary Table for ANOVA
on Visual Items Correct* Within Lesson

*Total possible = 16

- -

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	16.579	4	4.145	1.394	.242
Treatment	1.633	2	.817	.275	.760
Field Independence	14.428	2	7.214	2.427	.094
2-Way Interactions	8.735	4	2.184	.735	.571
A B	8.735	4	2.184	.735	.571
Explained	25.314	8	3.164	1.064	.395
Residual	273.498	92	2.973		
Total	298.812	100	2.988		

Table 8
Summary Table for ANOVA
on Verbal Items Correct* Within Lesson

*Total possible = 8

- -

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	88.499	4	22.125	1.736	.149
Treatment	13.128	2	6.564	.515	.599
Field Independence	74.514	2	37.257	2.924	.059
2-Way Interactions	43.709	4	10.927	.857	.493
A B	43.709	4	10.927	.857	.493
Explained	132.208	8	16.526	1.297	.255
Residual	1,172.425	92	12.744		
Total	1,304.634	100	13.046		

Table 9
Summary Table for ANOVA on Composite
of Visual and Verbal Items Correct* Within Lesson

*Total possible = 24

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	57.164	4	14.291	1.472	.217
Treatment	3.919	2	1.960	.202	.818
Field Independence	51.740	2	25.870	2.665	.075
2-Way Interactions	41.579	4	10.395	1.071	.376
A B	41.579	4	10.395	1.071	.376
Explained	98.743	8	12.343	1.272	.268
Residual	893.019	92	9.707		
Total	991.762	100	9,918		

Table 10
Summary Table for ANOVA
on Visual Items Correct* Within Test
*Total possible = 16

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Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	155.102	4	38.775	2.441	.052
Treatment	11.440	2	5.720	.360	.699
Field Independence	146.165	2	73.083	4.601	.012
2-Way Interactions	62.177	4	15.544	.979	.423
A B	62.177	4	15.544	.979	.423
Explained	217.279	8	27.160	1.710	.106
Residual	1,461.493	92	15.886		
Total	1,678.772	100	16.788		

Table 11
Summary Table for ANOVA
on Verbal Items Correct* Within Test
*Total possible = 16

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Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	372.573	4	93.143	2.184	.077
Treatment	3.054	2	1.527	.036	.965
Field Independence	369.577	2	184.789	4.333	.016
2-Way Interactions	144.479	4	36.120	.847	.499
A B	144.479	4	36.120	.847	.499
Explained	517.052	8	64.632	1.516	.163
Residual	3,923.146	92	42.643		
Total	4,440.198	100	44.402		

Table 12
Summary Table for ANOVA on Composite
of Visual and Verbal Items Correct* Within Test
*Total possible = 32

TITLE: A Review of Task Analysis Techniques for Education and Industry

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"A Review of Task Analysis Techniques for Education and Industry

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Abstract

A representative sample of task analysis procedures were examined for common components, methods, and terminology. Resulting generic components were discussed and categorized into two phases of task analysis: task description and instructional analysis. Task description included the components of task inventory, ordering, and refinement. Instructional analysis was comprised of the specification of needs, goals, objectives, learning hierarchy, learning taxonomy, training considerations, instructional specifications, and development procedures. Identification of these permitted the formulation of a generalized model of task analysis. It contained a consensus of procedures comprising educational and industrial task analysis applications.

"A Review of Task Analysis Techniques for Education and Industry

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Task analysis is a procedure for sequencing structural units in the design of training or instruction. A generic term covering various types of "front end" analysis, task analysis contributes to research from both a theoretical and practical base (Dick, 1981).

As an interface among theories of knowledge, instruction, and learning, task analysis serves three roles: as a prescription of the prerequisites and conditions under which optimal performance may occur (a theory of instruction); as a description of the behaviors and processes through which performance may be efficiently achieved (a theory of learning); and as a means by which basic questions concerning the relevance and utility of performance may be explored (a theory of knowledge) (Davies, 1973).

In general, the accepted method of task analysis involves specifying the task's terminal components and subsequently ordering its instructionally useful, prerequisite subtasks (Gibbons, 1977). In practice, however, there are many ways of determining the hierarchical or linear relationship among the constituent elements and identifying the learning processes associated with each (Gibbons, 1975). Despite a long history of successful applications of task analysis (Mager, 1962), users lack agreement regarding terminology and methodology (Duncan, 1972). In fact, Duncan calls task analysis an art. Identification of the common components of task analysis procedures would be the first step in standardizing terminology and methodology.

In this paper, a comprehensive sample of task analysis procedures were compared. Common procedural components and key concepts were isolated.

Methods were contrasted. The identification of "common denominators" across the representative task analysis procedures permitted the determination of the structural relationship between procedural components and formulation of a generalized model of task analysis with standardized terminology.

Methods

Procedure

An exhaustive review was conducted of all articles dealing with theory or application of task analysis published between 1979 and 1982 in National Technical Information Service, Psychological Abstracts, and ERIC. A total of 415 articles from these sources were reviewed along with additional articles identified in bibliographies.

Of the 415 articles, about two-thirds were immediately discarded. They were not useful for our purposes because their abstracts did not contain a reference to discernible procedures for conducting a task analysis. Many of these were project specific technical reports. Of the remaining 149 abstracts, access to the articles was limited to 52. These articles were helpful for generating references to older articles describing task analysis procedures. The topics of the available references varied widely, spanning learning theory (Wildman and Burton, 1981; Singer and Gerson, 1978; Fleishman, 1978), developmental theory (Spada, 1978; Siegler, 1980; Swinton, 1977), diagnostic-prescriptive special education applications (Arter and Jenkins, 1979; Burton, 1976; Ewing and Brecht, 1977), and job analysis training applications (Cornelius, Carron, and Collins, 1979; Arvey and Mossholder, 1977; Prien and Rosen, 1971). From the 52 articles and their references, ten representative articles containing fully-developed methods were retained for further examination.

From this sample, the components of task analysis were listed in the terminology and order presented in the article. A Q-sort procedure was utilized to group the descriptions of components by similarity of process content. A generic term and operational definition were then applied to cover each group of discrete processes. The rationale for these ordering and labeling procedures was to derive our basis of comparison from the models themselves as opposed to comparing the models to a predetermined schema.

Results

Task Analysis Methodologies

A matrix was prepared of the ten task analysis methods cross-referenced against common components that were present in one or more of the methods (see Table 1). The term the author used to name the components was reported as well as the order in which the component was addressed in each method. This generalized model of task analysis contained all of the nonredundant components of the procedures we examined: task inventory, ordering, refinement, needs, goals, objectives, behavior hierarchy, behavioral taxonomy, training considerations, instructional specification, and development. A discussion of each method ensues followed by a description of the common components of task analysis.

Of the selected task analysis procedures, two were applied to educational problems. Both Resnick et al. (1973) and Merrill (1973) began at an elementary level of description of educational task. Merrill proposed a detailed eleven-step procedure starting at the level of operationally defined concepts and relational operators. In addition, he addressed current issues in the theory of task analysis such as the inclusion of horizontal hierarchy analysis while evaluating prerequisites. With Merrill's method of analysis, the sequence of operations in a task are flowcharted with decision points or branches noted. This information processing approach employs the techniques of observation of overt behavior and "thinking aloud" of covert behavior. Unique is Merrill's position that neither hierarchical analysis nor information processing analysis is adequate for all skills. Both forms of analysis may be used to supplement each other by identifying instructionally important behaviors that would be missed by either approach alone.

Resnick applied task analysis in the development of an introductory mathematics curriculum. Resnick's method of analysis resulted in a hierarchy containing the terminal task on top, sequentially related subtasks ranked next, and a hierarchy of learning tasks below each subtask. Resnick's "chain of component behaviors comprising a skilled performance" was a synthesis of Gagne's hierarchical analysis, Merrill's information processing analysis, and Scandura's flowcharting. Resnick's method both sequenced tasks and prescribed teaching strategies. Resnick agreed with Gagne and Merrill that verbal knowledge was not amenable to this type of analysis.

Most of the applications were industrial. Gard (1972) and Gilbert (1972) presented models of task analysis at a conference sponsored by Bell Laboratories. Gard, reporting on an application for training systems designers, described a four-step procedure for task analysis: clarify tasks as activities, inputs, or outputs; organize a hierarchy; assign a taxonomy value; and achieve expert consensus of the analysis. Gard's method of analysis which can be considered gross level of information processing was similar to Merrill's. Output of gross analysis methods served as input to other methods of analysis. Gilbert's rationale for his task analysis procedures was based on cost effectiveness not psychological theory (Gibbons, 1977). He focused on reducing training costs by isolating deficiencies with a knowledge and learning taxonomy matrix and then suggesting training in the deficient areas. The estimated payoff of mismatches between actual and desired performance was used to set priorities for training.

The products of some of the industrial applications were very highly detailed. Miller (1962) and Duncan (1973) formulated their task analysis procedures from highly procedural applications applied to training. For Miller, task analysis was "a process whose results provide data about human functions, which (data) in turn are used to determine the charac- of the system and its components." The main difference between these authors was over the use of learning taxonomies. Miller promoted the use of a learning taxonomy to prescribe instructional methods while Duncan maintained that task analysis was prescriptive only for determining training sequences and not for specifying training methods. Another detailed product was Martin and Brodt's (1973) task-based curriculum for hospital corpsmen. The tasks were categorized by means of syntactic clustering, a method of classifying individual task statements by parts of speech such as verbs, direct objects, and so forth. Herschback (1976) synthesized the work of a wide range of educational, psychological, and industrial researchers such as Gagne, Davies, Mager, Bloom, Marsh, and Seymour. The result was a procedural description for deriving instructional content through task analysis. The description provided a good overview of the components common to many task analysis procedures; however, his procedures for formulating this overview were not systematic. Hannum (1980) distinguished between job task analysis and learning task analysis and provided a multiphase description of the latter based heavily on the work of Gagné. Gregory's (1979) unique task analysis procedure was designed for jobs that were unusually nonprocedural. The tasks were described in terms of "action models" which incorporated mental events into the task structure. Full utilization of this model, still in the early development phases, would entail the use of user-friendly computers for gathering task data from experts and novices. The computer program would delineate an action model for training analysis from the differences between experts and novices on answers to questions related to job performance.

All of these applications of task analysis possessed what Gerlack, Reiser, and Brecke (1977) call "generality." That is, description of task analysis procedures complete with enough detail to be applicable to a class of problems as opposed to a single problem. Instructional developers could follow any one of the task analysis procedures.

Common Components and Standardized Terminology

It was found that the task analysis components could be divided into two phases, task description and instructional analysis. Description dealt with the inventorying, ordering, and refinement of task content. Analysis covered with the use of task analysis for the analysis of instructional design specifications for a given task or series of tasks.

In the latter phase the design procedures for systematic development were addressed by the specification of needs, goals, objectives, behavioral hierarchy, behavioral taxonomy, training considerations, industrial specifications, and development procedures. A discussion of the common components follows.

Most authors addressed the three task description components although the order and names they gave to these components varied. Task inventory involved a progressive redescription of task elements from global to detailed. Ordering referred to the arrangement of task elements according to their content or performance relationships. Refinement was defined as the interactive process used to derive an ordered task inventory meeting a set criterion and eliminating gaps and redundancies. A major decision in task description was the level of detail with which the tasks were described. Only one author, Duncan, identified a formula for level of description. His formula specified that description should cease when the cost of further detail exceeded the need for that detail.

The second phase of task analysis, instructional analysis, contained the activities that most instructional designers would label "development activities": needs, goals, objectives, learning hierarchy, learning taxonomy, training considerations, and product development specifications. Indeed, the activities in the instructional analysis phase of task analysis overlapped many of those listed by Andrews and Goodson (1980) as the components of a model of instructional design.

The authors who conducted a needs analysis of students, tasks, or resources used the results as a means of determining the basis of instructional goals. When needs assessment was conducted varied widely. Some authors, like Herschback, Gilbert, and Martin and Brodt, conducted needs analysis early in the task analysis procedure. All of these authors used the results of the needs assessment to plan subsequent development activities. In contrast, other authors, generally those concerned with education rather than training, conducted needs analysis late in their procedure. For instance, Merrill analyzed needs in step eight of his eleven-step procedure. Both Merrill and Resnick suggested compiling a statement of needs from the information obtained after administering a pretest to identify student achievement deficits.

The nature of the needs varied among training needs, learner needs, and recipient needs. For example, Martin and Brodt conducted a task statement analysis for training needs. In a separate step they categorized needs for determining recipient needs. Other authors such as Resnick, Gilbert, and Merrill identified learner needs. This distinction reflected a difference between examining a task and examining a learner's behavior for determining need.

Goals were defined as broad statements of instructional aims. A noticeable finding from the matrix was that six of the ten authors did not include defining goals as part of their task analysis procedure. However, authors who did not use goals usually specified objectives/ The specification of objectives appeared to be the product of the task description phase while the goals were the product of the instructional analysis phase. When the needs analysis centered on the task, as with Gard's procedure where the difficulty and frequency of specific activities were rated, objectives were viewed as synonymous with the final product of the task description phase usually in hierarchy form. For example, Gard did not begin task analysis with task description. Rather, he began by classifying tasks as activities, inputs, or outputs. Then he devised a behavioral hierarchy by sequencing this task information. Thus, for every activity there is an input and an output. In theory, objectives are derived from goals (Mager, 1972). In practice, as reflected in the matrix, this was not how things worked. Gilbert and Gard, for instance, did not do a task description. Their objectives were not derived from goals but came from behavioral statements. In task-based models, there was not a clear relationship between goals and objectives, as basic tenets of development would lead one to expect.

Objectives were always stated in behavioral terms whether they were generated from the task description phase or a priori. Only one author, Duncan, did not include objectives in his task analysis. He went directly from his task description to a training sequence which he empirically validated. His approach circumvented learning hierarchies and taxonomies.

The learning hierarchies component was defined as an arrangement of behavioral objectives according to prerequisite learning requirements. It is synonymous with prerequsite analysis in Gagné's terms. It was found that not many authors devised hierarchies. Resnick formed hierarchies by prerequisite analysis of terminal and enabling objectives. Gregory's interactive procedure started with positing a task. With an action model, he expanded this initial task into behavioral objectives. Simultaneously, he derived the prerequisite and subsequent tasks, thus generating a learning hierarchy.

Gagné (19) suggested that the behavioral hierarchy serve as the main source for determining training sequences. What is interesting to note was that some authors; namely, Miller, Hannum, and Duncan, derived their training sequence directly from the task hierarchy rather than from the learning hierarchy. That is, this group of authors derived their training sequence from the chronological analysis of the task as opposed to a prerequisite behavioral analysis. Confusion resulted by having the task hierarchy resulting from the task description treated synonymously with a learning hierarchy.

Learning taxonomies were defined as the classification of task related behaviors within the parameters of pre-defined types of learning. Only four authors used learning taxonomies in their task analysis. Hannum followed Gagné's taxonomy. Information processing taxonomies were utilized by Miller and Merrill. Gilbert's taxonomy was what he called a knowledge progression going from theory to application in five steps without employing information processing terms. We concluded that the purpose of the learning taxonomy was for determining teaching methods while the purpose of the learning hierarchy was for sequencing, so the two were not interchangeable in our model.

Training considerations were defined as an analysis of factors that constrained the scope of the instructional product. The educational applications of task analysis (Resnick and Merrill) ignored training considerations. Some industrial applications such as Duncan's included delimiting trainer responsibilities from those responsibilities that were rightly the organization's.

The task analysis component of instructional development specifications was defined as the prescription and sequencing of instructional methods. Authors varied in the techniques used for prescription and sequencing. Gilbert maintained that method and sequence were determined by the behavioral taxonomy. Hannum derived his sequence from a prerequisite analysis of subtasks. Miller utilized a chronological task description of behavioral clusters. In contrast with this group of authors were Duncan and Resnick who maintained that sequence could be prescribed by the task description but instructional methods could only be hypothesized. That is, rather than using a taxonomy to prescribe given teaching techniques, they strongly suggested more freedom with regard to teaching methods as long as the results could be validated empirically.

Discussion

From the inspection of the rows, it can be concluded that no author's procedure was complete in addressing all components. Also, from inspection of the columns, it can be concluded that no component was addressed by every author. Finally, the order in chich the common components were addressed varied from author to author. Most, if not all, task analysis procedures were generated primarily for their own idiosyncratic application. It is clear that the procedures for task analysis did not evolve systematically. Rather, different procedures proliferated in isolation, probably in response to the situation specific demands.

The most salient difference between approaches depended on whether the application was educational or industrial. The educational techniques focused on specific tasks which were analyzed into concepts and relationships between concepts. The industrial techniques focused on jobs which were then analyzed into tasks and subtasks.

Instead of breaking tasks into concepts, industrial developers divided jobs into sub-skills which were not concepts but were actions. In other words, educational applications worked at a cognitive level, while industrial training models worked on a directly observable level of behavior. Industrial applications of job analysis stopped just short of the cognitive analysis found in educational applications. Another difference between educational and industrial applications was in how needs were assessed. In educational applications such as Merrill's and Resnick's, needs were assessed by pretesting objectives. In industrial applications, needs were identified before objectives were written.

In both industrial and educational models, specification of objectives did not routinely follow specification of goals. No author used goals only, but many authors used objectives only. Objectives were always stated in observable, measurable form. It may be that the specification of goals is passé.

There was confusion between behavioral taxonomies and behavioral hierarchies. They have different uses and are not interchangeable.

Compilation of all identified common components resulted in a generalized task analysis model. Generic terms for these components constituted standardized terminology. Empirical validation of the model is needed to establish its worth in terms of the necessity and order of use of the common components.

	DESCRIPTION				ANALYSIS					
	TASK INVENTORY	ORDERING	REFINEMENT	NEEDS	GOALS	OBJECTIVES	BEHAVIORAL HIERARCHY	BEHAVIORAL TAXONOMY	TRAINING CONSIDERATIONS	INSTRUCTIONAL SPECIFICATIONS DEVELOPMENT
HERSCHBACK	#6 Construct detailed task list	#7 Define tasks, task elements, and sub-elements		#2,3,4,5 Define instructional specifications	#1 Define program aims		#10, 8, 9 Define specific behaviors, performance conditions, and requirements		#10a Behavior analysis	
GILBERT				#1d,e Description and impact of deficiencies	#2 Identify behavioral deficiencies relevant to each accomplishment	#1a-c Description of job accomplishments, requirements, and standards		#3 Plot deficiencies by knowledge progression		#4 Construct a knowledge map which prescribes method and sequence
GARD				#3 Assign taxonomy values (i.e., difficulty, frequency of activity)	#4 Gain professional consensus (concerning needs)	#1 Identify: activities, inputs to activities, outputs from activities	#2 Sequence task information			
MERRILL	#1 Identify all possible concepts in the selected content area	#2 Determine relational operators #3 Specify change operations	#4 Define concept by relational operator #5 Represent each rule symbolically #6 Identify specific incidents for each generality	#8 Identify needs	Identify goals	#9 Specify mastery model		#10 Classify behaviors (associated with defined problems) as rule using, or rule finding		#11 Select and sequence course content

	DESCRIPTION				ANALYSIS					
	TASK INVENTORY	ORDERING	REFINEMENT	NEEDS	GOALS	OBJECTIVES	BEHAVIORAL HIERARCHY	BEHAVIORAL TAXONOMY	TRAINING CONSIDERATIONS	INSTRUCTIONAL SPECIFICATIONS DEVELOPMENT
MILLER	#1 General statement of job and task functions	#2 Breakdown of General statements into ordered job segments	#3a Identify major contingencies #4 Detailed task description			#5 Identify task behaviors #3b Identify behavioral conditions		#6 Taxonomize behaviors via defined information processing components	#7a Consideration of information processing components	#7b Methods derived from 7a. Sequence derived from chronological task description of behavioral clusters
HANNUM	#1 JOB TASK ANALYSIS Development of job function/task hierarchy					#2 Identify learning outcomes #3 Identify behavioral contributors		#4 classify capabilities into domains of learning (a la Gagne)		#5 Define training sequence as defined by prerequisite analysis
MARTIN/BRODT	#1 Develop task inventory	#2 Task/subtask analysis		#2 Task statement analysis (training needs) #3,4 Categorical needs analysis (patient needs)		#5,6,8 Syntatic analysis #12 Define behavioral objectives and criterion tests				
DUNCAN	#1 Identify the major operations of the job #3 Define subordinate operations to correct "level of description"	#2 Hierarchize major operations	#4 Define the plan						#7 Identify non-training considerations (i.e., equipment, design, personnel considerations)	#5 Identify training sequence as prescribed by task description. #6, 8 Hypothesize and test training methods

	DESCRIPTION				ANALYSIS					
	TASK INVENTORY	ORDERING	REFINEMENT	NEEDS	GOALS	OBJECTIVES	BEHAVIORAL HIERARCHY	BEHAVIORAL TAXONOMY	TRAINING CONSIDERATIONS	INSTRUCTIONAL SPECIFICATIONS DEVELOPMENT
GREGORY	#1 Generate a task activity			#5 Identify and diagnose training problems		#2 Develop an action model	#3 Elicit related action models #4 Roll action models to define the mode			
RESNICK				#5 Need assessed by pretesting objectives		#1 specify concept components in behavioral terms	#2, #3 Hierarchize terminal and enabling objectives by prerequisite analysis			#4 Sequencing based on order of performance #6, #7 Hypothesize, test and evaluate methods of instruction

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TITLE: Philosophical Foundations of Instructional Technology

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PHILOSOPHICAL FOUNDATIONS OF INSTRUCTIONAL TECHNOLOGY

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Philosophical Foundations
of Instructional Technology

INTRODUCTION

Traditionally philosophy has sought to provide answers/explanations to the following questions: (1) What is real? (metaphysics); (2) What is knowledge? (epistemology); and (3) What is of value? (axiology). Responses to these questions have provided competing philosophical frameworks for explaining/understanding reality.

Within education generally, we are concerned with these same questions, and there are competing educational philosophies that reflect divergent interpretations to the above questions. Depending upon our individual orientation toward living and our perception of the "world" (our immediate social-context), we consciously/unconsciously espouse a particular philosophy of education and act in certain ways within the classroom.

It is difficult to "separate-out" these three major areas of philosophical inquiry. They are inter-related and affect our explanations and conceptions of our immediate reality (context). For example, as I begin to identify the nature of the individual, the individual's place within society and the individual's perception of his/herself within society, i.e., in relationships (a metaphysical inquiry), I am also exploring how the individual arrives at certain interpretations of his/her environment (an epistemological question). As I begin to explore how individuals make choices that affect their lives on a day-to-day basis, I can identify what is of value to the individual (an axiological question). Thus in examining one area, I quickly become involved in the other two. This is particularly true when we begin to explore educational philosophy. In this paper I will focus on epistemology. Implicit in my discussion, however, will be metaphysical and axiological interpretations as well.

I chose to focus on epistemological questions for a variety of reasons: first, the notion of knowledge is of central importance to education generally, and hence, to the field of instructional technology; secondly, epistemology could provide us with a framework for critique of current practice within our field. This framework will suggest alternative theoretical understandings that could affect what we do; and thirdly, epistemological inquiry is one area within our field that is addressed directly by the model we use for curriculum organization (instructional design).

The remainder of this paper will focus on (1) developing an epistemological framework within which we could more clearly examine diverse modes of inquiry used to comprehend reality, and (2) the implications these modes of inquiry would have for future research within our field, specifically research of a conceptual/theoretical/philosophical nature. This framework could be used to situate our current practice and thinking within the field, and at the same time, point toward the need to generate greater diversity in research methodology.

I. DEVELOPING AN EPISTEMOLOGICAL FRAMEWORK FOR ANALYSIS

When talking about learning within the educational/academic setting, we use a variety of terms that tend to blend together and lose any nuance of meaning. They take on a common-sense understanding. For example, the terms knowledge, information, factual data, learning, process of learning, etc., are generally used interchangeably. If we are to develop an "epistemological framework" for analysis it would be of critical importance to clarify meaning and develop a more precise use of concepts and theory. To do this, I could turn to introductory texts concerned with the philosophical foundations of education (Cf. for example, Wingo, 1974; Ozmon and Craven, 1981; Bowyer, 1970;

Greene, 1973; Buford, 1969; Park, 1968; Duck, 1981; Gribble, 1969; Wirsing, 1972; _et_ _al_.). These texts would be most valuable to educationists in examining the theory base of their practice. For example, they would explain the perennialist philosophical tradition, which identifies truth and knowledge as universal and unchangeable. This would automatically define the subject matter for instruction. These texts would explain the pragmatist/experimentalist tradition as stated most clearly by John Dewey in his _Experience and Education_, _Democracy and Education_ and _The Child and the Curriculum_ and identify definite educational practice. These texts would explore existentialist philosophy and its statement for praxis within the humanistic tradition of education. And the same for phenomenonology, essentialism, reconstructionism, realism, idealism, etc.

Instead of pursuing this course I am going to choose another and briefly outline Jurgen Habermas' theory of knowledge and human interests (1971). Habermas is a contemporary German philospher who comes out of a different philosophical tradition, steeped in Kant, Hegel, Marx, Freud, Nietzche, Dilthey, etc. Habermas situates the notion of knowledge within a philosophical context, thus providing a framework for discussing this notion as it relates to education. This philosophical context acknowledges three forms of valid inquiry (the three forms of science) which generate three forms of valid knowledge. In acknowledging three forms of legitimate knowledge, Habermas relates knowledge with constitutive cognitive interest, thus eliminating objectivism (the objectivist illusion). Eliminating objectivism removes one of the primary legitimating factors of the application of the empirical method of inquiry as the _only_ valid form for arriving at knowledge. The non-neutrality of methods of inquiry (constitutive interests) is of critical importance to my discussion.

Knowledge and Human Interests

Habermas' "theory of knowledge" has three forms, or processes, of inquiry. Knowledge can be arrived at through (1) the empirical-analytic sciences, (2) the historical hermeneutic sciences, and (3) the critically oriented sciences (critical theory).[1] These forms, or viewpoints, of knowledge result in three categories of possible knowledge:

> Information that expands our power of technical control; interpretations that make possible the orientation of action within common traditions; and analyses that free consciousness from its dependence on hypostatized powers. These viewpoints originate in the interest structure of a species that is linked in its roots to definite means of social organization: work, language and power (Habermas, 1971, p. 313).

These categories of possible knowledge thus establish the "specific viewpoints" from which we can know reality in any way whatsoever: "orientation toward technical control, toward mutual understanding in the conduct of life, and toward emancipation from seemingly 'natural' constraints" (Habermas, 1971, p. 311). These modes of inquiry with constitutive interests delineate the way in which subjects generate knowledge.[2]

For each form of knowledge (empirical-analytic, historical-hermeneutic, and critically oriented sciences) Habermas posits a "cognitive interest" (theory of cognitive interest) which is an "attempt to radicalize epistemology by unearthing the roots of knowledge in life" (McCarthy, 1978, p. 55). Cognitive interests are see as "general orientations" or "general strategies" that influence (guide) the forms of knowledge (McCarthy, 1978, p. 58). They have their basis in the "natural history of the human species," and are tied to "imperatives of the socio-cultural form of life" (cf. McCarthy, 1978, p. 55). This anthropological, self-formative history of the human species has a quasi-transcendental character. "Quasi-transcendental" is an obscure, problematic term. Interests are not pure abstractions, and yet they are not totally empirical propositions. They are not causes or determinants in and of themselves. They are general orientations/cognitive strategies toward inquiry.

Knowledge constitutive interests are thus

> . . . linked to the functions of an ego that adapts itself to its external conditions through learning processes, is initiated into the communication system of a social lifeworld by means of self-formative processes, and constructs an identity in the conflict between instinctual aims and social constraints. In turn these achievements become part of the productive forces accumulated by a society, the cultural tradition through which a society interprets itself, and the legitimations that a society accepts or criticizes (Habermas, 1971, p. 313).

Thus, knowledge-constitutive interests are formed in "the medium of work, language and power" (Habermas, 1971, p. 313).

The basic framework for Habermas' theory of cognitive interests can be summarized as follows: the "reintroduction" of consciousness into epstimelogical reasoning, placing the individual within an historical context that rejects the subject-object separation (objectivist illusion); situating and criticizing the epistemological questions within the framework of classical philosophy and modern positivism,[3] wherein knowledge and interest are separated, the world is viewed as fixed and the place of theory is to describe and enlighten (guide) life; delineating the three forms of knowledge (empirical-analytic, historical-hermeneutic, and critical sciences) that differ in their general "cognitive strategies;" and linking the cognitive strategies with "cognitive interests" which are seen as deep-seated anthropological interest of the human species in their self-formative historical context (cf. McCarthy, 1978, p. 59).

Habermas' theory of knowledge and human interests can be represented schematically as follows:

Ontological Elements of Self-Formative Process	Knowledge-Constitutive Interest	Type of Study
Labor (instrumental action)	Prediction and control	Empirical-analytical sciences
Interaction	Understanding	Historical-hermeneutic sciences
Authority	Emancipation	Critical theory

(Giddens, 1979, p. 45)

As mentioned in the beginning of this section, Habermas' theory has an important contribution to make to our understanding of the notion of "knowledge" within educational theory. First, Habermas situates the concept "knowledge" within a philosophical (epistemological) context thus providing a framework for discussing this notion within the educational setting. Secondly, this philosophical context provides us with alternative forms of inquiry that can be used to make valid knowledge claims, and thirdly, in acknowledging alternative forms of valid knowledge, Habermas relates knowledge with constitutive interest, thus removing the objectivist illusion of value-neutral investigation. Let us briefly consider these three points.

1. Habermas' philosophical framework for discussing the notion of knowledge provides the basis for an analysis of questions related to epistemology, e.g., What constitutes valid knowledge? How do we arrive at valid knowledge? What are the objects of knowledge? What criteria of evaluation do we have?, etc. When I apply these questions to the educational setting, the questions take on a moral dimension: who determines what knowledge is to be taught? This situates education within a moral framework, which runs counter to present notions of education as a value-neutral activity/process.

The field of educational technology is an integral part of education generally, particularly regarding curricula material, both in the organization of curricula for instruction (instructional design) and the production of materials (software) for instruction. Thus we are also involved with epistemological questions stated above. Educational technology, as a field of study, has its theoretical base within the framework of a scientific, behaviorally-based model of rationality. Our field needs to expand its theoretical base to include other modes of valid rationality, which will require us to reconceptualize our underlying assumptions regarding the nature of the subject (persons), our theory of knowledge, and our instructional design model for organizing and evaluating the learning process.

Considering the notion of knowledge within a philosophical context also clarifies the confused status afforded philosophy within education:

> Educators practice a division of labor based on a tacit agreement, according to which the educational philosophers deal with the problem of "Aims and Values in Education" whereas all other educational research concentrates on practical problems, like improvement of teaching and educational administration methods, motivation, educational counseling and guidance, curricula, and so on. What all these problems have in common is their concrete and topical nature. This is why people engaged in research tend to regard philosophy as if it were an anachronism; no one can decide whether to throw it away as junk or put it in a museum. This attitude characterizes not only educationists. It is symptomatic of the climate of opinion in an era in which one discusses both the end of ideology and the end of metaphysics. "Aims and Values in Education" have a half-ideological, half-metaphysical status. Most probably, this is one of the reasons why the problems at the center of educational research do not deal with the aims of education but rather with means of implementing them. The educational researcher does not seriously question the purposes of education (Rosenow, 1976, p. 280).

In not questioning the purposes of education (e.g., education as socialization into status quo social structures vs. education as the critical capacity to make choices that aim at social change), educational theorists bypass this critical issue and "package" curriculum ("knowledge") under the protection of "value-neutrality."

2. The philosophical context provides alternate modes of inquiry as making valid knowledge claims. It distinguishes between empirical, hermeneutic,[4] and critical modes of inquiry, and does not try to group them under one method. It distinguishes between the different objects under investigation, e.g., natural/social phenomena. Different objects of inquiry require different methods of inquiry. Habermas stresses that each form of inquiry is a valid means of "arriving at" knowledge, with a constitutive interest. Thus, Habermas' theory could expand the means of investigating "subject matter" within the educational setting (for teachers-students).

3. In acknowledging alternate forms of valid inquiry, Habermas relates knowledge with constitutive interests, thus arguing that the "discovery" of human interests, constitutive of knowledge in the natural, cultural, and critical sciences, removes the objectivist illusion, yet does not destroy the broad concept of knowledge of its "genuine validity." Habermas thus finds interest "not an agent which destroys knowledge but rather the source of the ultimate foundation of knowledge" (Lukowsky, 1977, p. 65).

Scientific certainty, interpretive understanding, and/or critical reasoning and analysis: what are the objects of inquiry, and what are our aims within the educational setting?[5] These are critical issues that Habermas' theory poses to educational theorists, particularly theorists in the field of educational technology.[6]

DISCUSSION: Epistemology and Praxis

It is my contention that the field of education generally has relied almost exclusively on one mode of inquiry, namely the empirical-analytic mode.[7] This is true within the field of instructional technology particularly in the area of curriculum organization (instructional design based on systems theory)[8] and research methodology.[9] This has essentially taken the form of applying a scientific/technological model to the educational setting in order to explain or interpret the setting. Yet if I accept Habermas' theory of knowledge and interest as valid, our field has neglected two alternative forms of inquiry as valid means for arriving at knowledge. This would mean that there are foundational issues and understandings within our field that we need to reconceptualize. I believe this could enhance our practice and research efforts, and open the avenue for dialogue with other members of academia who work from a radically different philosophical base than that which dominates our field.

In this section of my paper I would like to examine some ideas that I believe would be fruitful areas for research. The kind of research that I am suggesting will be of a conceptual/theoretical nature. If our theoretical-base is not clearly articulated, our efforts will be sporadic and disjointed.

Utilization of Media Within the Educational Context

Instructional media convey information that represent particular interpretations of reality. The interpretation represented is open to debate. This is accomplished through questioning and "calling into question," through interpretation and analysis. Thus interpretive understanding and critical thinking become the metadologies of inquiry. Our rationale for utilizing media for instruction is altered within this framework. Our research efforts here could be quite varied and innovative, focused on the analysis of language used to identify individual perception. Our research "findings" would not be definitive and generalizable, yet could lead to greater individual self-understanding.

Curriculum Organization and Content

The area of curriculum development is directly tied to epistemology.

Here our field has relied exclusively on an empirical, systems based "scientific" model (instructional design). This model has a long tradition within the curriculum field. Cogent critiques of the systems approach, however, at least warrant our serious attention.[10]

The Instructional design model (e.g., Banathy, 1968; Kemp, 1977; et al.), as a means of organizing the learning process, has a constitutive interest in controlling that process. Control is consititutive of the model itself, the nature of the model. The instructional developer (teacher) makes all the decisions regarding the organization and planning of the learning process, and this is done usually prior to meeting students who will undergo the instruction. One primary legitimating factor for using this "scientific/systematic approach" to designing instruction is the objective nature of the results planned for. Yet, as Habermas has pointed out, methods of inquiry have constitutive interests. Empirical methodology has an interest in control. This is verified in praxis by examining the instructional design model and programs that have been designed according to the model. Knowledge is predetermined, what students will "think, feel and learn" is predetermined, by someone other than the students. The major difficulty with applying a control model to the learning process is centered on questions that point toward the "non-neutrality" of education:' "Whose knowledge is it? Who selected it? Why is it organized and taught in this way? To this particular group?" (Apple, 1979, p. 7). Linking these questions with the emphasis on standardization of methodology and outcomes that is characteristic of the instructional design model, and the model's emphasis on control of the learning process, any deviation from predetermined outcomes cannot be considered. Thus all students who go through the structured learning activities of the model are expected to arrive at the same point (input-output model). I believe this is a reductionist and simplistic view of education that poses strict limitations on what is determined "legitimate knowledge," and how one arrives at legitimate knowledge.

If I look at alternate forms of rationality (other than the empirical-behavioral form), following Habermas, I can arrive at knowledge through interpretive understanding (Verstehen) and critical science. In working with symbol systems, e.g. in analyzing the language of film, the language of video, the language of photography, visual imagery, etc., I am situated in another mode of rationality, I am looking for interpretive understanding. When these interpretations are open to critical analysis, I am situated in yet another mode of rationality, that of critical science, critical thinking and analysis. The empirical model of education does not use/recognize interpretive understanding or critical thinking as methodology. I suggest we need to explore alternative ways of organizing curricula that acknowledge that students are capable of having valid views of the world and at the same time recognizing that those views are open to critical analysis.

There are other models of curricula organization that we could explore. We will need to examine the literature outside of our field that is specifically concerned with curriculum development. This too is a fruitful area for future research and alternative praxis (cf. Koetting, 1981). Our research efforts will be of a theoretical/conceptual nature, and once the theory/conceptual base is clearly explicated (a legitimate research endeavor), testing the frameworks will demand varied research techniques and reporting. Again, definitive, generalizable conclusions regarding the "one best" curriculum organizational model will not be our research aim. However, greater understanding of the complexity of the curriculum organizational process could result and enhance our praxis.

Evaluation and Research

Alternative methods of inquiry reach different forms of knowledge. Empirical science is one form of knowledge, not the only form (cf. Habermas, 1971). Hermeneutic understanding is also knowledge, as are the understandings arrived at through self-reflection on the self-formative process (critical method). These results cannot be summarily evaluated through an empirical model of education. The notion of epistemological ambiguity must be recognized as part of the human condition. Exactitude/certitude and/or predictability of outcomes does not adequately represent the total criteria for all forms of evaluating educational outcomes. We need to go beyond a "control" or management model of organization, inquiry and evaluation, to an intersubjective, emancipatory model. This will involve diverse conceptual frameworks for analyzing schooling, and alternative modes of inquiry.

Self-expression and communication of ideas within a non-scientifically oriented classroom will demand and allow for diverse modes of communicating those ideas. Thus, as there are diverse forms of knowledge, there are also diverse ways of expressing, communicating, learning and evaluating ideas and conceptions of the world. The teacher, as well as the students, need to determine what kind of knowledge they are seeking, and/or the nature of the knowledge they have arrived at.

Similarly, research methodologies applied to the educational setting need to be chosen with an understanding of the type of knowledge the researcher wants to attain in his/her investigation. For example, if I wanted to know

> the number of words a child can spell or the frequency of interaction between children of different races in desegrated schools, then statistical procedures are appropriate. However, if we want to understand the relevance of the words to the child's particular life or the meaning of interracial interactions then some form of qualitative methodology (e.g. Verstehen) . . . . which allows the researcher to obtain first hand knowledge about the empirical social

> world in question may well be more appropriate (Patton, 1975, p. 13).[11]

In other words, the empirical method of investigation, would be an inadequate method of investigation to summarily investigate the social setting[12] (e.g. life in classroom), and/or problems within that setting (e.g. the nature of authority in classrooms, the control of knowledge in classrooms, the nature of school work, etc.). With emphasis on outcomes (ends), the process (means) becomes secondary, unless the outcomes have been correctly predicted, and the means become standard treatment. If successful prediction and control of outcomes are our major aims, then the empirical method of investigation and the "scientific" organization of the subject matter would be acceptable. Yet the search for

> Objective control over the multiplicity of interdependent events occurring in a classroom has led to a concentration on ever smaller units of behavior, divorced from context and sampled in rigorously scheduled time units (Shapiro, 1973, p. 543)[13]

The emphasis on greater and greater control of classroom learning keeps us rooted in a technological, quasi-scientific research paradigm. There are alternatives to these methods. If we can apply Habermas' theory of knowledge and human interests to our own individual quest for self-understanding, I believe we can better understand the need for alternative modes of inquiry within our research endeavors.

Concluding Comments

The areas for research within our field are substantive and expansive. Yet if we acknowledge the empirical paradigm as the only legitimate means of acquiring significant knowledge about our world, we are cutting ourselves off from the traditions of the cultural sciences. We need to employ as many means as possible to help us better understand our world. An examination of the philosophical foundations of education is a good place to begin to explore the complexities of the schooling process and how that process is affected by our view of the larger context.

Engaging in philosophical debate within our own field of instructional technology can only lead us to further explorations. These explorations will not be confined to academic matters, but will become a personal quest. We deal with philosophical questions everyday: What is real? How do we know? What is of value? As I stated in the beginning of this paper, these are questions that affect what we do professionally. They also affect us on a deeply personal level, and become the basis for everything we do.

FOOTNOTES

[1] When involved in empirical, scientific investigation, quantification of data made through observation is the knowledge generated. In hermeneutic science, dialogue replaces the observation, and hence intersubjective understanding (Verstehen) is the knowledge generated. Arriving at meaning (intersubjective understanding) is not a major aim of research in the field of educational technology. Yet recognition of the need for alternative research designes in our field (i.e. alternatives to the experimental/behavioral designs) has been voiced. cf. Ann D. Becker, "Alternate Methodologies for Instructional Media Research," in AV Communication Review, Vol. 25, No. 2, Summer, 1977.

My primary concern in presenting Habermas' theory, however, lies not in research designs, but rather in ways of arriving at knowledge, i.e., legitimate methods of inquiry that can be applied to classrooms. Hermeneutic understanding, as methodology, is a common form of rationality that individuals use in many social settings (e.g. when in small group situations, in talking with friends, etc.). My argument is that we then need to allow for/acknowledge this form of rationality as a legitimate manner for arriving at knowledge within classrooms, which will take us out of the realm of applying one form of rationality, viz. the empirical form.

[2] In education, generally, the dominant form of knowledge (mode of inquiry) is based on empirical science. We need to recognize and allow for the various forms of inquiry and the kinds of knowledge generated. This will require a reconceptualization of key concepts within the field of education in general, and the field of educational technology in particular.

[3] cf. McCarthy, The Critical Theory of Jurgen Habermas, (Boston: Mit Press, 1978), op. cit., pp. 138-139. Also see Russell Keat and John Urry, Social Theory as Science (London: Routledge and Kegan Paul, 1975), pp. 219-220, who outline four features of critical theory that stand in opposition to

positivist tradition: critical theory 1) sees existing reality as basically "irrational;" 2) tries to identify the "possibilities for change in that reality, the relations and developments that are already operating to undermine the continuation of its present form;" 3) attacks the ideology stemming from existing social reality, and which "systematically conceal these potentialities for radical transformation," and 4) it rejects positivism and the assumptions positivism makes as regards social science. Also see Barry Smart, Sociology, Phenomemonology, and Marxian Analysis (London: Routledge and Kegan Paul, 1976) for a similar outline of the characterstics generally attributed to the positivist tradition in sociology (pp. 77-8).

For the positivist tradition as influencing the theory base of educational technology, see Robert Gagne's The Conditions of Learning (New York: Holt, Rinehart and Winston, 1977), pp. 2-3; and Wood and Wylie, Educational Telecommunications (Calif.: Wadsworth Publishing Company, Inc., 1977), pp. 241-248.

[4] Hermeneutic understanding, as inquiry, would be most applicable in humanities courses, and also would be a crucial form of rationality to be applied to analysis of media productions, particularly in treating language as symbol, and the symbolic language used in media productions (e.g. the language of film, the language of photography, video, etc.). Yet the notion of "meaning" is not a common understanding in educational research. Rather than appealing to diversity of interpretations (meaning), appeal to "brute date" is the accepted practice not only in research in education, but in the manner of arriving at "legitimate" knowledge.

[5] The empirical method of investigation, with its assumptions as outlined in the beginning of this section, would be an inadequate method of investigation to summarily investigate the social setting (e.g. life in classrooms), and/or problems within that setting (e.g. the nature of authority in class-

rooms, the control of knowledge in classrooms, the nature of school work, etc.). With emphasis on outcomes (ends), the process (means) becomes secondary, unless the outcomes have been correctly predicted, and then the means become standard treatment. If successful prediction and control of outcomes are our major aims, then the empirical method of investigation and the "scientific" organization of the subject matter would be in order. Similarly, if interpretive understanding (meaning), or critical reasoning/analysis is our major aim, then alternative forms of inquiry are needed.

[6] The important understanding to be aware of in the discussion concerning methods of inquiry and forms of knowledge, is the notion of constitutive cognitive interests, as outlined by Habermas. There is no rejection or dismissal as to the validity of each form/method of inquiry, only critical debate over their application.

[7] _cf_. Michael W. Apple, _Ideology and curriculum_ (London: Routledge and Kegan Paul, 1979); Henry Giroux, _Ideology, Culture and the process of schooling_ (Philadelphia: Temple University Press, 1981); Eliot Eisner, _The educational imagination: on the design and evaluation of school programs_ (New York: Macmillan Publishing Co., Inc., 1979); Herbert Kliebard, Bureaucracy and Curriculum Theory. In Pinar, W. (ed.) _Curriculum Theorizing: the reconceptualists_ (Berkeley, California: McCutchan Publishing Co., 1975); _et al_.

[8] I have outlined this idea elsewhere. _cf_. Koetting, _Towards a Synthesis of a Theory of Knowledge and Human Interests, Educational Technology and Emancipatory Education: A Preliminary Theoretcial Investigation and Critique_. Unpublished Doctoral Dissertation, University of Wisconsin-Madison, 1979, especially Chapter III; and Koetting, "Reconceptualizing the Theory-Base of Educational Technology: Reopening the Theory-Practice Debates." _Proceedings of_

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selected research paper presentations. Association for Educational Communications and Technology, Research and Theory Division, Philadelphia, PA (April, 1981, pp. 289-344).

[9] For an excellent statement of this position regarding research, cf. Jeffrey Lukowsky, "Reconstructing the history of educational technology provides us with new models of research," in Proceedings of selected research paper presentations, Association for Educational Communications and Technology, Research and Theory Division, Philadelphia, PA (April, 1981, pp. 409-427).

[10] cf. the citations in footnote seven, especially "Systems management and the ideology control," in Apple (1979), Chapter six; also see "Curriculum form and the logic of technical control: building the possesive individual," in Michael W. Apple (ed.) Cultural and economic reproductions in education: essays on class, ideology and the state (London: Routledge and Kegan Paul, 1982).

[11] Also see C. Wright Mills, The sociological imagination (New York: The Grove Press, 1961), pp. 73-74.

[12] cf. Ann D. Becker, "Alternate Methodologies for Instructional Media Research," in AV Communication Review, Vol. 25, No. 2, Summer, 1977, who suggest some limitations of behavioral research designs as used in educational technology and offers some possible alternatives. Also see Francis E. Clark and Jay F. Angert, "Research on Media - where Do We Go From Here,? unpublished paper presented at the AECT National Convention, Research and Theory Division, New Orleans, Louisiana, 2979. The authors of these articles argue for the need of alternative research strategies to the behavioral model.

[13] cf. Patton, Alternative Evaluation Research Paradigm (Grand Forks, N.D.: University of North Dakota), 1975, who expands on this use of standardized

tests:

> The problem is not simply one of finding a new or better standardized test. The problem is one of understanding the context of observed behaviors, the meaning of specific achievement outcomes to the child in a more holistic setting than is possible with any standardized test. This does not mean that standardized tests may not be useful for certain specific questions, but they are not sufficient when the issue is understanding, not just prediction. Understanding in its broadest sense requires getting close enough to the situation to gain insight into mental states; it means subjectivity in the best scientific sense of the term. The alternative paradigm seeks to legitimize and incorporate this subjectivity into evaluation research, not to the exclusion of the methodology of the dominant paradigm, but in addition to it (p. 25).

Also *cf*. Elliot W. Eisner, *The Educational Imagination* (*op*. *cit*.) Chapter One.

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TITLE: Field Independence-Dependence Demographic Data Analysis

AUTHOR: Cynthia L. Krey

FIELD INDEPENDENCE-DEPENDENCE
DEMOGRAPHIC DATA ANALYSIS

BY

CYNTHIA L. KREY

UNIVERSITY OF MINNESOTA

JANUARY 1983

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Introduction

In general, research demonstrates that cognitive style, particularly Field Independence/Dependence (FI/D), has something to offer the instructional designer. Within the framework of Psychological Differentiation, FI/D lends itself well to an integrated, holistic approach to creative instructional design. As with most research, however, there are limitations. Some of the issues connected with FI/D include:

- reliability, validity, and correlation of FI/D test measures
- emphasis on FI vs. FD within a value-free construct
- relationship of FI/D to other individual difference variables; such as IQ, sex differences, and cultural background

These issues have been discussed throughout the literature over the past decade. Historically, the first two issues have been dealt with extensively by Herman A. Witkin and his colleagues.

FI/D Test Measures

Since the early 1970's, the Group Embedded Figures Test (GEFT) (Witkin, Oltman, Raskin, and Karp, 1971) has been used somewhat consistently in research conducted on FI/D. The GEFT was developed by Witkin and his associates to facilitate measuring FI/D. Its advantages (compared with earlier measures) include cost, availability, large-group format, time, ease of transport, and ease of administration. The GEFT consists of eighteen items. For each item, subjects are asked to locate a hidden figure within the embedded context of a complex pattern. Each subject's score, then, is the number of correct tracings of simple figures on complex designs. Three sections are included in the timed test, but scores on the last two sections only are used. Performance on the GEFT reflects a tendency, in varying degrees of strength, toward analytical or global functioning.

Reliability, Validity, and Correlation of FI/D Test Measures

Investigations on the reliability and validity of the GEFT reported by Witkin and his associates (Witkin, et al., 1971), using college student samples, indicate acceptable reliability coefficients (Spearman-Brown = .82) and reasonable indications of validity.

Reliability of the GEFT has been confirmed in the literature. Internal consistency coefficients using the Spearman-Brown prophesy formula have been reported by Dumsha, et al. (1973) at .84. Additionally, Lis and Powers (1979), using a sixth grade sample, calculated long-term (i.e., 1 year test-retest) coefficients of stability of .80 and .71 for boys and girls respectively and coefficients of internal consistency ranging from .83 to .98 for boys and girls on the GEFT.

The validity of the GEFT has been questioned. Lis and Powers (1979) reported construct and concurrent validity at -.60 for sixth grade boys and at .00 for sixth grade girls. This study raises the issue whether the portable Rod and Frame Test (RFT) and the GEFT (when administered to this sixth grade population) actually measured the same individual difference variable.

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In response to similar questions concerning the correlation of various tests for FI/D, Witkin cites numerous studies which link such measures as the Body Adjustment Test (BAT), the Rod and Frame Test (RFT), and multiple forms of the Embedded Figures Test (EFT) (Witkin, 1977). Most recently, however, Witkin and Goodenough (1981) suggest that differences existing between FI's superior performance on the RFT and the BAT as opposed to the Rotating Room Text (RRT) and conversely FD's success on the RRT are the result of abnormal laboratory manipulation that separates visual and gravitational cues; thereby, creating a situation that learners will never encounter in the real world. In my opinion, this issue is a fundamental one. I am not completely satisfied, as Witkin and Goodenough (1981) imply, that performance differences on varying FI/D measures are created simply as a result of semantic differentiation. "'Field dependence- independence' and 'cognitive style' were used, at different times, as labels for different dimensions in a hierarchiacal set. These variations, and particularly some of the more recent usages that have come into vogue, have created problems that have been the source of critical comments in the literature. We believe the model now proposed does not involve these problems and provides a conception of cognitive style more consistent with common usage than our previous conception. The first problem the new conception addresses has arisen from the use of the term 'field dependence-independence' in several difference ways in the literature. Our very earliest use of the term, as we have seen, was for the dimension of individual differences in tendency to rely primarily on the visual field or the body as referents for perception of the upright. Later it was used to refer to ability to overcome an embedding context in perception."[1]

It is unlikely that this issue can be easily resolved. It would seem, as long as research is conducted using either the early measures from the "perception of the upright" group or more recent measures of the "embedded figures" variety, one can avoid the issue. However, further research is required.

FI/D as a Value-Free Cognitive Style Variable

Witkin and Goodenough have argued from a rational, intellectual viewpoint that FI/D is a value-free construct (Witkin et al., 1977; Witkin and Goodenough, 1981). In my opinion, FI/D is only value-free when it is isolated from society. Globally, it may be true that, given a variety of cultures, the attributes of FI/D are equally valued throughout the world. However, on an individual basis, within a particular society, one or the other of the bipolar characteristics of field independence/dependence is likely to be preferred.

The basis for Witkin's early position that FI/D is a value-free construct is based on the premise that "primary reliance on the body would lead to a more accurate performance in some situations, whereas reliance on the visual field would lead to more accurate performance in other situations."[2] No similar statement is made about the ability to overcome embeddedness. However, if one believes FI/D to be truly value-free, then the ability to easily isolate embedded figures would be important in some situations; whereas, the lack of ability to do so should be important in others. In our society the analytical, articulated individual with the ability to disembed and restructure is at an advantage. This is probably true of other highly technological societies as well. For this reason, I am unable to accept the notion that FI/D is value-free. Perhaps, rather than conduct research attempting to classify the bipolar nature of FI/D, it might be more useful to study ways in which to accommodate the dichotomy.

The Relationship of FI/D to Other Variables

The question concerning the relationship of FI/D to other variables has been studied for over twenty years. Goodenough and Karp (1961) addressed the issue using factor analysis. The results of this early study indicated that there are commonalities involving the capacity to overcome an embedding context in both FI/D and intellectual functioning. At the time this study was conducted, no relationship between verbal comprehension and FI/D was found. However, recently Witkin and Goodenough (1981) have reported eleven studies that indicate a correlation exists between vocabulary and GEFT scores. Goodenough explains that the correlation is the result of cognitive restructuring ability but does not relate to conventional IQ measures. Since IQ is generally measured by verbal-comprehension factors and attention-concentration factors which do not involve restructuring, Witkin and Goodenough conclude that a greater overall capacity of field-independence over field-dependence really does not exist.

Cross-cultural studies, sex difference studies (as related to societal groups), as well as, genetic difference studies are all a part of the greater issue "what is being measured by tests of field independence/dependence?". Witkin (1967) and others have noted a slight sex difference, especially in Western cultures, between field independent and field dependent subjects. Whether FI/D is an indicator of child rearing differences, societal differences, biological differences, or a combination of psychological and neurophysical aspects of the individual must be continually assessed. If FI/D is simply a measure of intellectual functioning, as seen in cognitive restructuring tasks, decisions which affect other individual difference variables must be considered carefully.

The following study attempts to analyze some of these variables in relationship to field independence/dependence.

Background

Subjects, all 6th grade students attending an inner-city public elementary school in a multicultural environment (ns = 98), took the Group Embedded Figures Test (GEFT) and a standardized set of math and reading tests. No sex differences were found within any of the cultural groups. However, an extremely suggestive correlation was found between math test scores and GEFT scores within the four cultural groups tested. No correlation was detected based on number of parents, number of siblings, year of birth, or reading test scores for any group.

The literature suggests field independent/dependent tendencies are linked to sex differences in adults (Huteau, 1977; Witkin, et al., 1977; Lotwick, et al., 1981), but, possibly due to variations in testing procedures, are not reported in populations comprised of preadolescent children (Witkin and Goodenough, 1981). Further, research indicates that sex differences in adults may have origins in a multitude of genetic and/or cultural variables (Huteau, 1977; Witkin and Goodenough, 1981). Further, The demographic data analysis presented in this study confirms the lack of significant sex differences in preadolescent children using the GEFT. It also suggests that field independence/dependence tendencies are closely linked to individual differences in analytic/mathematical ability. As noted by Guilford (1980), cognitive style seems to manifest itself in vocational and educational choices.

"Those high in FI are likely to prefer natural sciences, engineering, and mathematics."[3] No significant differences were isolated based on other possible culturally-related variables.

Subjects

The subjects were ninety-eight 6th grade, elementary students (52 female and 46 male) representing four cultural groups (50 White, 35 Hispanic, 7 S.E. Asian and 6 Black). The setting was an inner-city school involved in multicultural education. Forty percent of the total school population were minority school students living within a few miles of the school. A special music program for talented youth was being offered at the school to draw nonminority students into the area. The school housed grades 4 - 6 as well as the offices for the district bilingual program.

Tests

Students were given standardized math and reading tests in the fall of their sixth grade year as part of an annual school district testing program. All students were tested on the same dates, at the same hour of the day, and in relatively similar testing environments, using the SRA testing series. The following spring, students were given the GEFT as part of a series of research projects conducted throughout the school. Although only twenty minutes is usually allowed for the GEFT, it was decided, with a sixth grade population, to time each section of the test at 13 minutes. Each group of students was given the same set of directions and shown the same examples prior to the test. The entire measure, including directions, took 45 minutes.

Method

In addition to these 3 test scores (math, reading, and GEFT), demographic data was collected on each student. Sex, race, year and month of birth, number of parents in the home, and number of siblings in the home were included as variables. Statistical analysis using the SPSS package was done combining all the data collected over the school year. The following tests were run after entering the raw data:

1. A series of descriptive statistics, including frequencies and histograms
2. ANOVA (race groups and sex variables)
3. ANOVA (minority vs. non-minority and sex variables)
4. ANOVA (# of parents, # of siblings and birthdate variables)
5. Correlations between all variables
6. ANACOVA - classical approach (race and sex with reading and math)

7. ANACOVA - regression approach (race and sex with reading and math)

8. ANACOVA - classical approach (race and sex with math only)

9. Tests of all ANACOVA assumptions

Results

As Table 1 indicates, no significant correlation was found between EFT scores by sex or cultural group. Collapsing the four cultural groups to represent White/Non-White subjects did not result in substantially different findings from those reported on Table 1.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	F	Significance of F
Sex	3.453	1	3.453	.151	.698
Race	118.839	3	39.613	1.735	.165
2-way interaction	1.525	3	.508	.022	.995

Table 1

No differences were found between EFT scores and the number of parents in the home, the number of siblings in the home, or the month and year of birth. It was originally speculated that perhaps large, single-parent families would have an effect on subjects' EFT scores. Also, the cut-off date for sending children to kindergarten creates classes with subjects that have spent from one to eleven months longer in their home environment. The possibility that maternal influence and/or other culturally-specific experiences might affect EFT scores was also considered. Based on face-value, raw demographic data, no differences were found. However, such factors as nursery school, head start experiences were not accounted for. A more detailed study of these variables could possibly produce significant results.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	F	Significance of F
Year	5.726	1	5.726	.276	.601
Race	124.527	3	41.509	1.998	.120
2-way interaction	99.190	3	33.063	1.591	.198
Parents	.005	1	.005	.000	.988
Race	72.262	3	24.087	1.069	.366
2-way interaction	40.772	3	13.591	.603	.615
Siblings	9.424	1	9.424	.581	.452
Race	49.592	3	16.531	1.019	.399
2-way interaction	Due to an empty cell, high order interactions have been suppressed.				

Table 2

Some interesting results can be reported from the correlations between all variables using Pearson correlation coefficients. A 13 x 13 matrix was designed using all the original data collected in the study. A summary of only those variables which suggested significant correlations is presented on Table 3.

	F	Significance of F
EFT x Race	- .2138	.017
EFT x Math Score	.4764	.001
EFT x Reading Score	.4138	.001
Race x Reading Score	- .1575	.061
Number of Siblings x Reading Score	- .2260	.013

Table 3

It is possible that correlations with race are affected by relatively small cultural group cells. However, it is interesting to note strong significance with relatively small samplings. The group sizes were:

1. White = 50
2. Hispanic = 35
3. S.E. Asian = 7
4. Black = 6

From this data, one can only speculate that reading ability may be impacted by socioeconomic status and the number of siblings in a family. Perhaps the lack of time, interest, and/or ability to provide adequate early childhood experiences in the area of reading is a contributing factor.

No correlations were found for the variables listed on Table 4.

EFT x Sex
EFT x Number of parents
EFT x Number of siblings
EFT x Birthdate

Sex x Race
Sex x Reading score
Sex x Math score
Sex x Number of parents
Sex x Number of siblings
Sex x Birthdate

Race x Math score
Race x Number of parents
Race x Number of siblings
Race x Birthdate

Reading score x Number of parents
Reading score x Year of birth

Math score x Number of parents
Math score x Number of siblings
Math score x Year of birth

Number of parents x Birthdate
Number of parents x Siblings

Number of siblings x Month of birth

Table 4

EFT seems to be exhibited in areas which require intellectual processing. In the past, research indicated strongly suggestive results which pointed to cultural and sex differences. At least two reasons may account for the lack of sex difference correlation in this study:

1. The difference in EFT testing measures and their implementation.

2. The changes in our society toward women and their role in society.

Based on the information reported on Table 3 an ANOCOVA using race and sex with reading and math scores was run. The results between the classical and the regression approaches were similar. The results for the classical approach are reported on Table 5.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	F	Significance of F
Reading Score	12.609	1	12.609	.725	.397
Math Score	134.690	1	134.690	7.742	.007
Sex	2.339	1	2.339	.134	.715
Race	129.575	3	43.192	2.483	.066
2-way interaction (Sex/Race)	16.771	3	5.590	.321	.810

Table 5

Using the ANACOVA, this study confirms the significance reported in other studies linking an analytical/mathematical perspective with field independence. An interesting effect is also noted in adjusted and unadjusted mean scores on the EFT when this ability is accounted for. See Table 6.

	Means	
	Unadjusted	Adjusted
Female	9.00	8.79
Male	8.24	8.47
White	9.20	8.72
Hispanic	8.77	9.14
S.E. Asian	7.43	9.44
Black	4.67	4.10

FI = 11-18
FN = 7-10
FD = 0- 6

Table 6

Possible causes for the difference in mean scores by race may include:

1. Cell size difference
2. Socioeconomic status differences among White vs. Non-White
3. Cultural value systems towards education
4. Natural analytic/mathematic ability unaccounted for on standardized math tests
5. Bi-lingual interferences, in that, GEFT directions were read aloud and demonstrated visually without verbal interference.

A second ANOCOVA was run using only math scores as a covariate. The results appear on Table 7.

Source of Variation	Sum of Squares	Degree of Freedom	Mean Square	F	Significance of F
Math Score	499.136	1	499.136	28.552	.001
Sex	18.253	1	28.253	1.044	.310
Race	117.982	3	39.327	2.250	.088
2-way interaction (Sex/Race)	17.548	3	5.849	.335	.800

Table 7

No significant results were noted on any of the tests of the ANOCOVA assumptions.

Discussion

The results of the demographic data analysis in this study provide confirmation for the analytic/mathematical aspect of field independence. This suggests that Witkin's Theory of Psychological Differentiation may have direct instructional application (Witkin, et al., 1977). Teaching students to increase their analytic capacity could provide them with useful tools to compete in a high field independent environment. More research is required in the area of analytical/restructuring tasks, within cultural groups; especially those not necessarily measured on standardized tests. Since reading ability, per se, is not closely related to EFT it is likely that the application of analytic processing techniques may apply to verbal tasks as well.

Summary

Based on the demographic data analysis of this sixth grade population, the following findings were confirmed:

1. no significant sex differences in preadolescent children using the GEFT were noted.
2. field independent/dependent tendencies seem closely linked to individual differences in analytic/mathematical ability.

However, no significant differences were isolated based on other possible culturally-related variables.

NOTES

1. Witkin, Herman A. and Donald R. Goodenough, Cognitive Styles: Essense and Origins, International Universities Press, Inc., New York, New York, 1981, p. 58.

2. Ibid, p. 14.

3. Guilford, J. P., "Cognitive Styles: What Are They?", Educational and Psychological Measurement, 1980, Vol. 40, pp. 719-720.

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TITLE: Learning, Instruction, and Education:
The Psychological Perspective

AUTHOR: Barbara L. Martin

LEARNING, INSTRUCTION, AND EDUCATION:
THE PSYCHOLOGICAL PERSPECTIVE

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PRE-CONVENTION DRAFT

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Learning, Instruction, and Education:
The Psychological Perspective

The purpose of this paper is to describe and discuss the theoretical underpinnings on which the field of Instructional Technology is based from a psychology perspective. First, the psychology of learning will be explored from a historical vantage point. Major learning theories and their assumptions will be briefly defined. Second, four instructional theories will be described and compared along dimensions important to instructional technologists. Finally, some thoughts and speculations will be given about how seemingly opposing theories might be reconciled.

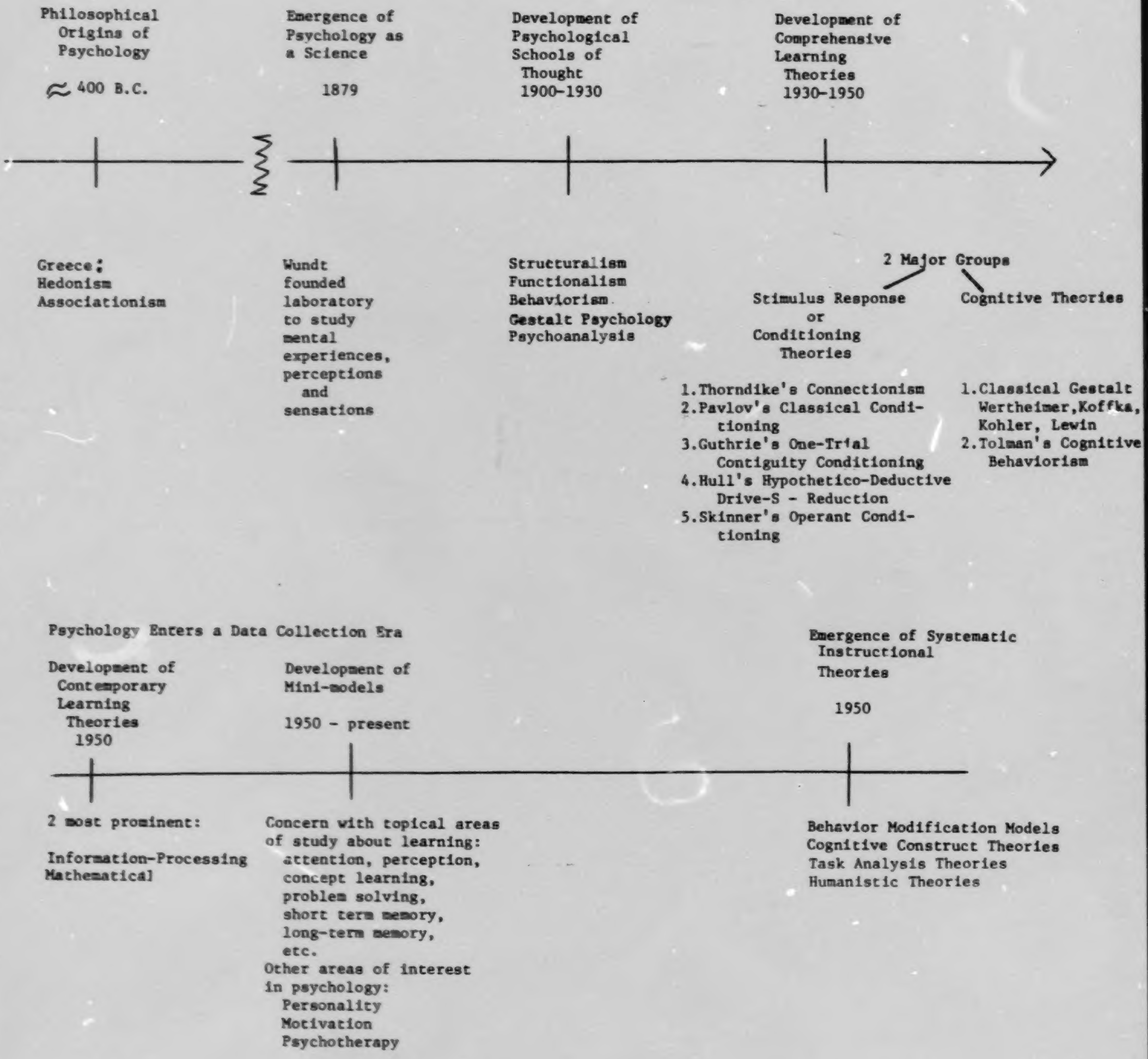
An Overview of Learning Theories

The study of learning and instructional theories is relatively new, little more than one hundred years old. The timeline (Figure 1) shows the development of the psychology of learning.

In general, psychology evolved from five schools of thought in the early 1900's to two major groups of comprehensive learning theories around mid-century. The two dominate groups, S-R or conditioning theories and cognitive theories, developed largely as philosophical positions even though differences within each group were often as intense as differences between groups. The major characteristics of each group are:

Figure 1

Continuum Depicting the Development
of Psychology
(Adapted from Snelbecker, 1974)



Philosophical
Origins of
Psychology

≈ 400 B.C.

Greece;
Hedonism
Associationism

Emergence of
Psychology as
a Science

1879

Wundt
founded
laboratory
to study
mental
experiences,
perceptions
and
sensations

Development of
Psychological
Schools of
Thought
1900-1930

Structuralism
Functionalism
Behaviorism
Gestalt Psychology
Psychoanalysis

Development of
Comprehensive
Learning
Theories
1930-1950

2 Major Groups

Stimulus Response
or
Conditioning
Theories

1. Thorndike's Connectionism
2. Pavlov's Classical Conditioning
3. Guthrie's One-Trial
Contiguity Conditioning
4. Hull's Hypothetico-Deductive
Drive-S - Reduction
5. Skinner's Operant Conditioning

Cognitive Theories

1. Classical Gestalt
Wertheimer, Koffka,
Kohler, Lewin
2. Tolman's Cognitive
Behaviorism

Psychology Enters a Data Collection Era

Development of
Contemporary
Learning
Theories
1950

2 most prominent:

Information-Processing
Mathematical

Development of
Mini-models

1950 - present

Concern with topical areas
of study about learning:
attention, perception,
concept learning,
problem solving,
short term memory,
long-term memory,
etc.
Other areas of interest
in psychology:
Personality
Motivation
Psychotherapy

Emergence of Systematic
Instructional
Theories

1950

Behavior Modification Models
Cognitive Construct Theories
Task Analysis Theories
Humanistic Theories

S-R Group	Cognitive Group
1) emphasize analysis of behavior	1) emphasize internal processes and structures, e.g., thinking
2) study simple learning processes to understand complex ones	2) emphasize perceptual organization of experiences and situations
3) regard psychology as a natural science with important governing laws	3) maintain that the S-R group studies the results of learning.

These two groups formed the core of psychology as late as 1950. A major argument at the time centered around the question whether S-R connections were the product or result of learning. This was largely a philosophical debate with little empirical fact to support either position. Kendler (1952) suggested that: a) the answer might not lie in empirical evidence; b) the choice itself could not be evaluated as right or wrong; and c) the matter was purely one of personal taste. Yet, the question continued to be explored and argued; remnants remain today.

Concurrently, other areas of interest in psychology, e.g., personality and motivation, were also growing and psychology moved into an era of miniature model building based on inductive inquiry. Presently, several theoretical positions are viable and continue to be developed, while new theories have emerged. The state of the art is:

1) The S-R theories are still prominent.
2) Gestalt theories have been incorporated into other theories, primarily the cognitive group.
3) Humanistic theories with their emphasis on feelings and emotions have re-emerged; and
4) Two new theories, information theory and mathematical theory, have appeared. Information theory focuses on measuring information flow; mathematical theory focuses on the use of mathematical equations to describe learning.

In addition, no comprehensive learning theory has been developed and the possibility of doing so seems virtually impossible since the trend has moved away from theory construction and toward data collection and amassing evidence to support particular propositions. This trend has resulted in the continued proliferation of miniature models, a situation presenting a significant problem for practitioners trying to synthesize and use learning theory.

Regarding the two major groups, S-R and cognitive theories, Snelbecker (1974) summarized the view of some psychologists as they look toward the end of the century. "Many view the first part of the century as having been the province of stimulus-response psychology and they contend that since mid-century, we have moved into an era that will be completely dominated by some form of cognitive psychology, most likely under the information-processing orientation" (Snelbecker, 1974, p. 108). It is still frequently argued that the two theoretical positions are incompatible and that practitioners and researchers must choose between one group or the other. Snelbecker argues, however, that the two positions can and must be reconciled and contends that this can be accomplished by accepting the differing points of view from which each group approaches the learning process, i.e., the phenomenological first-person view and the behavioral third-person view of the learning situation.

Instructional Theories*

The field of Instructional Technology is largely concerned with practices that lead to improvement of educational practice rather than with basic science research concerning how people learn. Instructional theory has more bearing on these issues than does learning theory because: a) learning theory is descriptive; instructional theory is prescriptive and b) conceptions of the process of teaching/instructing are broader than conceptions of how one learns. Most instructional theories, however, are closely aligned with a learning theory and are guided by its assumptions and philosophical bases.

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*The instructional theories are described and discussed from the perspective of school rather than non-school settings.

Table 1 lists four major instructional theories comparing them on several important characteristics and listing major strengths and weaknesses of each. The theories are: a) behavioral, b) cognitive, c) task analysis, and d) humanist. The table was constructed from Snelbecker's (1974) discussion of each theory and the reader should consult this source for more in-depth analysis or for clarification.

Although the behavioral and task analysis theories and the cognitive and humanist theories are most closely aligned, the task analysis approach has some important cognitive characteristics and the humanists have been as critical of cognitive approaches as they have of behavioral approaches. With this in mind, we will look at each instructional theory or position--the humanists actually do not have a theory, but rather a philosophical position--from three vantage points particularly germane to the field of Instructional Technology, i.e., goals, procedures and strategies, and evaluation.

Goals. The behaviorists are neutral with respect to goals and what should be taught in schools. They maintain that an adequate, useful theory should have established procedures

Table 1

Some Important Characteristics
of Instructional Theories
(Taken largely from Snelbecker, 1974)

Theories Characteristics	Behavioral Theories	Cognitive Construct Theories	Task Analysis Theories	Humanistic Theories
Major Theorists	Skinner, Hull, Guthrie, Pavlov	Bruner, Ausubel, Piaget, Torrence, Simon	Gagne, Briggs, Glaser, Melton	Rogers, Maslow, Allport, Combs, May, Fromm
Dominant Psychology Theory *not a learning theory	Operant Conditioning Reinforcement	Information-Processing Developmental Perception	Eclectic, but favors behavioral theories	Perception Personality Theory* Clinical Psychology*
Learning Domain Emphasis	Cognitive Psychomotor	Cognitive -internal structures emphasized	Cognitive -subject matter concerned with vocational or professional interests	Affective -learning is becoming -responsible students
Focus of Schooling Efforts	-behavior changes -product oriented	-thinking, problem solving, concept formation -process oriented	-simulus-response through problem solving -acknowledges impt. of higher levels	-self-develop- and growth -human potential -process oriented
Teacher Role	Directs Manages Reinforces	Guides Stimulates discovery	Predesigns instruction Manages by arranging conditions	Facilator-creates emotional and intellectual environment
Instructional Strategics and Procedures	Small steps Strengthen bonds leading to objectives Frequent assessment	Discovery Inquiry	Prerequisite skills Internal and external conditions	Experiential Emotionally meaningful student choice
Point of view of Learner in the Theory	3rd person	1st person	3rd person	1st person
Major Strengths	Research based Theory compatible w/data Commitment to research and eval. Operational definition of objectives	Even without empirical support, educators favor this position Characterizes learner as active information processor	Identifies 8 types of learning in taxonomy Derived from learning theory Sound empirical base Delineates limitation of theory	Concern with "whole" person-feelings, experiences, and behavior. Student choice Focus on interpersonal relationships
Major Weaknesses and criticisms	Primarily applicable to low level and/or factual learning. Student choice of objectives minimal. Validity of law of effects questioned Overly simplistic Findings from animals not appropriate for humans	Theorists have not developed a competing theory. Small data base Little interest in empirically testing instructional principles.	May not deal adequately with most important kinds of school learning. A best taxonomy is a matter of opinion. Task analysis procedures and using taxonomy to specify objectives is difficult and requires much practice.	Reaction to learning Theories - primarily a philosophical position Little empirical validation Can student determine what he needs to learn? Terms used do not lend themselves to operational definitions

applicable to all objectives. They do, of course, support operational definitions and predesigned instruction but do not take a curricular position concerning what should be taught.

The task analysis theorists, particularly Gagne and Briggs, support predesigned rather than extemporaneously designed instruction. Gagne has developed a taxonomy of eight types of learning primarily useful for goals related to the student's quest for a vocation or profession. Gagne's problem-solving type of learning is very similar to cognitive conceptions, but he does approach instruction from a behavioral perspective. Gagne, concurring with the cognitive theorists, suggests that the problem-solving type of learning may be the most important goal of schooling (Gagne, 1970). Gagne very thoughtfully acknowledges the limitations of his approach including those related to motivation, attitude and value development, personal interaction, etc., but states that these are not of central concern to his taxonomy which is concerned with the development of goals related to academic subjects and career paths.

The cognitive theorists emphasize thinking processes and inquiry skills as the most important goals of education. In general, they see no limitations to their approach; it is applicable to all subject matter, all disciplines, and all students.

The humanists take the position that the most important goals of schooling are learning how to learn, assuming responsibility for learning, and self-development. While recognizing and acknowledging the importance of facts and knowledge, Rogers sees this as a secondary goal. The humanists endorse a view of man that would lead to fundamental changes in the purposes and goals of schools.

Procedures, Methods, and Strategies. The behaviorists and task analysis theorists emphasize predesigned instruction and fairly structured learning environments. The behaviorists favor individual pacing, frequent assessments to determine student progress, use of systematic procedures for modifying methods and strategies, use of reinforcement and contingencies, and small step learning.

Gagne and Briggs endorse analyzing tasks in hierarchical order and sequencing instruction according to prerequisites. Hilgard and Bower (1966) referring to Gagne's taxonomy, state, "...it is by no means clear that a sequence of instruction can be designed upon it, or that the basic notion is sound that the lower steps of the hierarchy have to be mastered before the higher steps can be learned. There may well be a kind of cyclical development in learning, in which the various stages repeatedly assert themselves" (p. 571). In addition to his taxonomy, Gagne places a strong emphasis on the structure of knowledge and describes instruction as a process of matching or arranging internal learner conditions with external environmental conditions so that learning occurs. A wide variety of methods and procedures is encouraged.

Cognitive construct theories emphasize discovery learning and inquiry process skills. They endorse these as goals of education as well as instructional procedures. They suggest beginning with the organized structure of knowledge and expanding from the essentials or the essence to details. They emphasize that: a) there is not always one right answer as behaviorists seem to endorse, b) the educated guess is an important aspect of creativity and discovery, and c) learners must be active participants in the learning process. Sequencing, according to Bruner, should progress from concrete, to graphic, to symbolic.

Humanistic psychologists focus primarily on creating an emotional environment. Rogers is more interested in the process of learning than in how to teach. He opposes additive learning and emphasizes student choice and emotional involvement. His procedures are quite eclectic favoring discovery and inquiry, but he acknowledges the benefits of programmed instruction to fill gaps in student knowledge. The major distinction between the behaviorists' use of PI and the humanists' use is the student's desire to learn and student selection of PI as the route to take.

The teacher's role varies quite considerably from theory to theory. The behaviorists and task analysis theorists prescribe a more directive teacher both during the design of instruction and during implementation. The cognitive theorists endorse the role of teacher as guide and facilitator. The humanists encourage teachers to create an emotional environment designed to foster learner self-growth. Interestingly, none of the theories adequately addresses the learner as a group member, but focus primarily on the individual student.

Assessment and Evaluation. The behaviorists explicitly define objectives and procedures for evaluation. The teacher is primarily responsible for evaluating student progress.

The cognitive theorists believe that the student should develop his own means for evaluating his progress. They acknowledge, however, that this is easier in subject matter or content areas where divergent thinking is not stressed, e.g., math.

Task analysis theorists, like the behaviorists, believe strongly in predetermined objectives and criterion-referenced evaluation. Periodic evaluations are seen as a major means for improving both student learning and evaluating the instructional process.

Humanists oppose teacher-centered evaluation and believe students should assess their own progress. One of the major criticisms of this theoretical position has concerned the student's ability to set his own learning goals and evaluate his own progress.

Theory bases of Instructional Technology. It will certainly come as no surprise to anyone that the field of IT is most closely associated with the behavioral and task analysis theories, rather than with cognitive and humanist theories. This is to be commended for several reasons:

1. Behavioral and task analysis theories are the most empirically sound and thoroughly researched.

2. The operational definition of objectives allows for sound evaluation procedures.

3. These theories focus on the readiness of learners for instructional objectives and procedures, and

4. Gagne's Taxonomy is seen by some as the beginnings of a unified instructional theory (Hilgard and Bower, 1966, p. 569).

Perhaps the major criticism of behavioral and task analysis theories is that the behaviors addressed are not those of most importance to education and the goals of schooling. Snelbecker (1974) suggests that Gagne's taxonomy is biased toward those aspects of learning that have been most thoroughly studied rather than what is most important. This criticism is perhaps less one of the viability of the theory and more one of philosophical orientation, i.e., what are the major goals of schooling? Another major criticism, however, is that Thorndike's law of effect, on which behaviorism is based, may not be valid according to information-processing research.

Although the cognitive theorists have not actually developed a competing theory or gathered empirical support for their instructional principles, public opinion tends to favor this position (Snelbecker, 1974). Likewise, the humanists have failed to develop a theory supported by research; yet, their focus on student feelings and emotions is a very appealing position.

Some Concluding Comments and Observations

Teaching is a purposeful activity. Whether the goal is to teach academic subject matter, create a nurturing environment, or develop thinking processes, teachers begin, knowingly or unknowingly, from one or more philosophical or psychological frameworks and plan, however loosely, for some desired effect. One of the major areas of conflict between behaviorists, task analysis theorists, cognitivists, and humanists is the extent to which preplanning can be accomplished. The behaviorists and task analysis theorists have shown that instruction can be predesigned, implemented, and evaluated. The goals they select, however, are often straightforward and amenable to their approach. Some have suggested that the behavioral approach is excellent for use with training goals, but is inappropriate for loftier educational goals. The cognitive and humanist theorists also support preplanning but focus their efforts on arranging the instructional environment so that students experientially learn academic content, develop problem-solving and thinking skills, and grow emotionally and affectively.

The reconciliation of these theories does not seem to be a matter of which is right or even which is most appropriate for a given situation. During any instructional situation, there are times where one or another theory or some combination is appropriate and should be used. Rather, the question of reconciliation is to me one of combining the strengths of each group.

At the risk of over-simplification, I see the strength of behavioral and task analysis theories as two-fold. First, there is a methodological strength. The rigor of establishing goals, specifying criterion measures, matching activities and strategies to objectives and learners, plus the use of a feedback mechanism to revise and improve instruction is a positive element of these theories. Behaviorists recognize the potential of their methodologies when they suggest that an instructional theory must work with any objective and "even instructional failures may be helpful since one can more precisely define the sources of the problem" (Snelbecker, 1974, p. 405).

Another methodological strength is the use of task analysis procedures. Most theories, particularly the information processing and behavioral, suggest that problem solution is largely dependent on the nature of the task; task analysis procedures are encouraged. Wildman and Burton (1981) suggest the use of task analysis to understand how the expert problem solver organizes and structures knowledge. They state that this process may be a useful way to address internal structures. Hilgard and Bower

(1966) reviewing studies of motor-learning also state the importance and necessity of task analysis, "...even what appear to be simple tasks are indeed quite complex, the psychological processes involved run the whole gamut from simple associative learning to higher forms of information processing..." (p. 547).

A second major strength of the behavioral and task analysis theories is the use of constructs that might be valuable content when teaching thinking and problem-solving skills. Since nothing succeeds like success, the student who successfully guides his own thinking and learning strategies may also increase his self-esteem and enjoyment of the tasks at hand. Some of the constructs used by these theorists that could also be viewed as content for facilitating internal structures and for guiding one's own learning include:

1. Systems Theory - setting goals, establishing boundaries, finding links and inter-relationships, evaluating results, etc.
2. Concept Development - learning to recognize classes of objects and ideas, discriminating among classes, and synthesizing classes.
3. Task Analysis - specifying the nature of the task, breaking it down into meaningful parts, synthesizing the parts into meaningful wholes.
4. Perceptual Theory - using concepts like proximity, closure, and similarity to organize and make sense out of data.

Such constructs--that do not come exclusively from behavioral and task analysis theories--might possibly be taught to students as content to enable them to guide their own problem-solving and creative endeavors.

From the cognitive and humanist theories, a major strength is that they force us to think about the purposes and goals of education and how to accomplish those goals. The continued focus on problem-solving, creativity, self-development, and other aspects of the affective domain as goals, and the view of the learner as an active information-processor and a developing emotional human has piqued our sensibilities and started us thinking about our attempts to foster these goals. The potential exists to develop the goals of these theorists using the methodology of the behavioral or task analysis theories. For example, the apex of an affective domain taxonomy might be something to the effect that "Each student creates within himself a positive internal environment." Here the focus is on learner self-development and creative problem-solving, yet the goal has the beginnings of an operational definition. Students who have previously learned to apply systems theory may have a mechanism for clarifying the intent of this goal for themselves and evaluating their progress in attaining it.

The quest for operational definitions of goals such as that mentioned above may help clarify the purposes of schooling and eventually aid in formulating sound instructional procedures for these goals. The insistence on affective education, developing internal strategies, problem-solving and creativity as goals of schooling should stimulate behavioral and task analysis theorists to try out their more complete theories or these goals. Where insufficient, it is hoped these theories can be expanded.

There is no comprehensive instructional theory but there are a number of points of agreement among theorists that can guide practice. Hilgard and Bower (1966) list twenty areas of mutual agreement including: a) an active learner; b) the use of repetition and reinforcement; c) the essential organization of knowledge from simplified wholes to more complex wholes; d) the generalizability and longevity of "learning with understanding;" e) the importance of goal-setting by the learner; and f) the effects of group atmosphere on what is learned and the learner's attitude toward the learning situation. (See Hilgard and Bower, 1966, pp. 562-564 for the complete list.) Instruction, however, is so complex that instructional theory must address a host of practical issues, e.g., motivation, attention, perception, interaction patterns, as well as state a philosophical orientation or belief about the purposes and goals of schools or the instructional situation. Still, much of what occurs in the classroom is experiential, intuitive, and based on common sense.

There are literally hundreds of avenues to explore; I have suggested one, i. e., that behavioral and task analysis methodologies may be useful in clarifying goals and finding strategies necessary to implement the goals proposed by cognitive and humanist theories. I also believe an eclectic theory, such as Gagne's that addresses behavioral, cognitive and information processing constructs, and describes a variety of types of learning, appears to be the most promising line of inquiry to pursue. His taxonomy, coupled with an affective taxonomy specifying behaviors such as self-growth and attitude development and linking the cognitive and affective dimensions, may lead us one step closer to a comprehensive instructional theory.

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TITLE: The Role of Pictures in Selecting Categories for Understanding Photographs

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The Role of Pictures in Selecting Categories for Understanding Photographs

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Designers of visuals have long been interested in how people read pictures. The communication of salient visual features becomes the visual producer's goal. Early empiricists determined that sensory processes as well as coding mechanisms described the activity of complex visual systems (Hochberg, 1962). The empirical attempt at understanding the psychology of visual perception has given us much information about light intensity, size of objects, placement, and figural recognition. Recognition and identification, however, account for only part of human visual perception.

In further efforts to determine how visual information is conveyed, researchers have recently drawn from the literature in psychophysics. Alleging that perception includes more than simply stimulus response, psychophysicists attempt to explain perception as the conceptualization of visual information at the point at which it reaches the eye rather than as a detached stimulus exhibiting constancy of size and shape (Gibson, 1966). Both empiricst and psychophysical approaches to perception have proven incomplete. Empiricists rely solely on stimuli. Psychophysicists suggest higher order variables without demonstrating their effectiveness (Haber, 1973).

Research in picture perception has followed similar lines. Empirical attempts to break photographs down into component parts for analysis have yielded inconclusive evidence. Memory studies have shown that viewers display a high degree of accuracy when remembering pictures previously seen (Shepard, 1967). However, whether a picture can be understood and remembered is not clearly a function of its stimulus properties alone. The perceiver brings a set of experiences, expectations, and a unique frame of reference to the viewing of a visual image. Humans also selectively perceive information. Gestalt principles of proximity, similarity, continuity, and closure have been used to explain how objects are grouped visually to extract meaning (Kohler, 1947).

These paradigms, applied externally to photographs, have not explained why people select certain visuals as more expressive nor how those visuals communicate their message. According to one anthropoligical model, sometimes referred to as New Ethnography, human events are best studied from within. Units of meaning, it is felt, should be discovered through the analysis of people's actions rather than imposed by external cross-cultural classifications. The terms etic and emic are used to refer to these approaches (Pelto and Pelto, 1970). The etic approach is applied externally and across cultures from an outsider's point of view. In the emic approach, on the other hand, as various elements emerge from within a person or a culture they develop and begin to take the form of patterns. It is in these developing patterns that discoveries are made which describe the particular behavior in question. In photographic research etic or externally identified variables have failed to uncover the rich information about human visual perception. It is timely, therefore, to investigate the emic or internal approach, in which viewers themselves create structure for meaning from photographs. By asking viewers of photographs to describe verbally what they are processing visually, it is postulated that a basic common vocabulary will emerge to describe the visual conceptualizations which are taking place.

Photographs have certain properties which are unique to the medium. In order to discover how photographs affect the viewer, the researcher may take one of two approaches. If we use anthropological terms, they can be described as Etic and Emic approaches to classification. Traditionally studies involving the reading of photographs have used the Etic appraoch. This method is based on an analytic or external approach. Assumptions are that the concepts identified are absolutes, are commonly understood by people of various backgrounds and can be defined and identified in advance or a priori. In our current example of research in photography, this means that we select terms which we assume everyone will understand. We often use a semantic differential, for example, and ask people to "Rate the impact of this picture along a continuum from beautiful to ugly". Subjects are asked to choose from among pre-selected bipolar adjectives that description most appropriate to the photograph. This scientific approach assumes that the significant concepts in the photograph have already been identified. Quantitative analysis of data resulting from a priori concept identification is then performed to determine how subjects view information in pictures.

A second example of the Etic approach is content analysis. In our recent study, viewers were given aesthetic concepts conceived by the photographers themselves. Participants were then asked to select, from a group, those photographs in which they could see the particular aesthetic categories described. Quantative analysis of data resulting from the identification of these a priori concepts showed that there was no uniform response either from undergraduate students or art professionals in their ability to recognize those categories which had been identified by the photographers. Although this method of inquiry is objective and scientific, it presupposes that the categories chosen are identifiable and are, indeed, the most significant aspects of meaning in the photograph. Defining these categories in advance appears to work if participants have similar backgrounds and if the externally identified aesthetic values are agreed upon. It seems that unless all viewers read photographs the same way, there will be no agreement on this type of externally imposed variable.

In our opinion the Emic approach, characteristic of what is called New Ethnography, offers a more realistic alternative for examining how we read photographs. The Emic system of classification is an internally based process which emerges through discovery. According to this view, cultural behavior is valid for only one group at a time and is best studied among people of similar backgrounds. Units of meaning are discovered rather than imposed from outside. Patterns which emerge from within the group are described afterward or a posteriori. Categories may be described verbally as they emerge, or they can be observed visually as a result of q-sort or free sort techniques. Our present research includes a series of studies using a free sort technique. In these studies viewers from similar backgrounds are asked to sort photographs into any groups they choose. There is no limit placed on the number of groups nor on the time they spend at the task. Over 100 photographs from magazines representing a wide variety of subjects and treatments are used. Participants are directed to "place the photographs with similar concepts together".

After a viewer has gone through a first sort each picture number is recorded. Participants are interviewed and asked what is similar about photographs in each group. The pictures are then shuffled and the viewer is asked to sort them again. This process is repeated until the viewer has no further categories for the pictures. Using this technique with many subjects over time, patterns and meanings begin to emerge. We are able, through multidimensional scaling, to synthesize categories which are important to a majority of participants. The taped interviews will give us verbal information consolidated with the visual information, which will lead to the development of a meaningful vocabulary for categorizing visual information in photographs. The grouping of pictures gives us the information visually. Interviews with participants will enrich that information verbally.

Pilot studies have indicated that viewers classify pictures first in terms of concrete concepts. Pictures of people often form one group. Pictures of nature and the out-of-doors form another group. Concrete concepts are the most readily accessible and the easiest way to identify and classify information. The second and third sorting seems to elicit more abstract but more "meaningful categories", In the words of the participants - they take longer to perform the task but typically are more enthusiastic about the ingenuity of their grouping. The interrelation of abstraction and emotion in photographs bears further study. Results from the pilot study already indicate similarities in visual categories identified, as well as in the verbal terms used to describe them.

If responses derived from a large sample indicate similar perceptions, interpretations, and verbal descriptors, then these descriptors can be identified and distinguished from others - an accumulation of such information may allow clustering of categories which contain meaning and which are significant to large numbers of people. This would serve as a stable data base for building a common vocabulary to describe the visual conceptualizations which are taking place and would ultimately be used in designing effective visual instruction.

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TITLE: Naturalistic Inquiry As A Research Methodology

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NATURALISTIC INQUIRY AS A RESEARCH METHODOLOGY

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Research in education has, for many years, meant quantitative research, an objective method of study which seeks facts and causes generalizable from one situation to another. It does this through the isolation, control, and manipulation of factors comprising the phenomenon under study. While much has been learned using these methods, the fact remains that not all educational questions are quantifiable. In a field so rich in humanity, so filled with variables that defy control, understanding a situation may sometimes be far more important than prediction or generalizability. Thus some educational researchers are beginning to extend their interests beyond the techniques and questions of quantitative analysis, exploring instead the flexibility and humanist perspective of naturalistic inquiry.

Naturalistic inquiry has its philosophic roots in a research tradition which differs greatly from that of quantitative study. It is this philosophic perspective which causes the divergence between the research methods each uses and the sometimes bitter disagreement as to what constitutes a valid study. In fact, the disagreement is usually based on a lack of understanding of the different purposes each method addresses. John Lofland (1971) presents these differences in a clear and simple way. Social inquiry, he tells us, usually attempts to find answers to three basic questions:

> 1. What are the characteristics of a social phenomenon, the forms it assumes, the variations it displays?
> 2. What are the causes of a social phenomenon, the forms it assumes, the variations it displays?
> 3. What are the consequences of a social phenomenon, the forms it assumes, the variations it displays? (page 13)

Quantitative analysis tends to simplify the first question by providing "operational definitions" for the "variables," or characteristics, of a phenomenon. The focus of this type of research is on providing answers to the second and third questions. Naturalistic inquiry, on the other hand, focuses primarily on in-depth, descriptive answers to the first question. The aim here is understanding the phenomenon rather than controlling it.

To understand naturalistic inquiry, its methods and its goals, it is necessary to understand the theoretical bases from which it derives. Two schools of thought, ethnography from the field of anthropology and symbolic interactionsism from sociology, provide an excellent beginning to understanding the theoretical perspective of naturalistic inquiry.

While ethnography can be defined as the study of culture, it is in reality more than that. It is the study of culture from the point of view of its people. Ethnography is based on the concept of culture as shared knowledge, thus the focus of interest is the way people think about things. In fact, Spradley (1979) defines ethnography as "learning from people" rather than studying people and feels this work must be approached "with an almost complete ignorance."

Symbolic interactionism is based upon a very similar theoretical perspective. Social scientists such as George Herbert Mead (1934) and Herbert Blumer (1969) view the human being as an acting rather than a responding organism. The assumption is that people act on the basis of the meaning things have for them and that in order to understand the actions of people, it is necessary to interpret objects as they do. "Objects," from this perspective, include not only the person doing the acting, but other people and their actions as well as the environment and the physical objects within it.

As can be seen, these theoretical perspectives differ greatly from those of the traditional experimental or quantitative study which attempts to make predictions based on the response of subjects to carefully controlled "treatments." While it is assumed that most people conducting educational research have some understanding of the strategies employed in quantitative research, those of qualitative research are not as well known. It is the purpose of this paper, therefore, to provide a forum for describing the use of naturalistic inquiry as a research methodology for education. Three aspects of the application of naturalistic methods to an actual research setting will be considered: selection and use of data gathering techniques; analysis of naturalistic data; and consideration of the results of a study within the framework of existing theory. Using as illustration a research study conducted at a major eastern university, each of these three aspects will be discussed in relation to the assumptions underlying naturalistic inquiry and to the difference between these assumptions and the ones underlying experimental research. It is expected that the comparison approach will provide the reader with an understanding of the difference between the two methodologies and a better standard by which to evaluate the quality of any naturalistic research studies which they might encounter.

Selection and Use of Data-gathering Techniques

Basic to naturalistic inquiry is an understanding of human behavior from the actor's own frame of reference. This differs from the positivist approach which attempts to get at cause through careful control of variables. Blumer (1969) describes how this philosophy affects the selection of research methods:

> The contention that people act on the basis of the meaning of their objects has profound methodological implications. It signifies immediately that if the scholar wishes to understand the actions of people, it is necessary for him to see their objects as they seem them ... To identify the objects of central concern, one must have a body of relevant observations. These observations ... are in the form of descriptive accounts from the actors of how they see the objects, how they have acted toward the objects in a variety of different situations, and how they refer to the objects in their conversations with members of their own group. (pages 50-52)

To view the world through the eyes of their subjects, qualitative researchers have used a variety of techniques limited only by the imagination of the researcher. Although the techniques are rigorous and empirical, aimed at as full a description of the situation under study as possible, researchers have successfully combined existing techniques and created new ones in an attempt to study and define events as they are experienced by real people in their everyday lives. There are, however, two basic techniques most frequently associated with naturalistic inquiry. These are participant observation and unstructured interviewing.

Participant Observation. Using this particular technique, researchers spend intense periods of time interacting with those they are studying. They participate in events or experience the situations they wish to understand. They talk at length and on a personal basis with other participants, gaining the acceptance and confidence of those they study as they share their feelings and experience (Bogdan & Taylor, 1975; McCall & Simmons, 1969). During these periods of observation, participant observers systematically collect and record data. The recording is usually outside the setting in which the data is collected so as to be as unobtrusive as possible. When recording, an attempt is made to recall and replicate as closely as possible what was said and done. For example, after observing a half hour development meeting involving two instructional developers and four professors with content expertise, I spent a total of two hours at the typewriter and ended up with twenty-one pages of observation including as many direct quotes as possible.

Unstructured Interviewing. Unstructured interviewing involves long, open-ended conversations with individuals in which the aim is to capture their perspective on a situation, activity, or event. The unstructured interview has been found to be a particularly useful technique by which to obtain subjective information about a situation from a respondent (Richardson, Dohrenwend & Klein, 1965). For this technique, the primary amounts of data should come from the respondent. It is important to phrase questions so they cannot be answered with a simple "yes" or "no." Transcripts of interviews I have conducted tend to have at least one page, and often five or more pages, of response for each question. In addition, questions of a more factual nature should precede those requiring personal revelation in order to build trust and confidence between interviewer and respondent. Interviews are generally tape-recorded for transcription at a later time and are usually at least one hour in length. In studies I have conducted, interviews vary in length from forty-five minutes to two hours.

Sampling Procedures. Theoretical sampling procedures (Glaser & Strauss, 1967) are generally used to obtain respondents for naturalistic studies. This type of sampling differs from statistical sampling where the major aim is a representative group which will allow the results of a study to be generalized to other settings. In statistical sampling, the subjects are chosen for the study using mathematical models to assure random selection. Theoretical sampling procedures allow the researcher flexibility in choosing subjects based on the needs of the study and in stopping data collection when sufficient information is collected. Using this procedure, the researcher will interview several subjects then, using the information he/she has obtained, new subjects will be selected to give a broader or deeper perspective to the problem being studied. When information becomes redundant, data collection can be stopped.

Application of Techniques to a Research Study. Employing the techniques of naturalistic inquiry, an indepth study was conducted at a major Eastern university to determine how professors thought about the instructional development process in which they had participated. All professors were, or had been, the clients of a campus-wide instructional development agency. Interview was selected as the primary method for this study based on four criteria developed by Richardson, Dohrenwend and Klein (1965). These are relevance, accuracy, accessibility, and the economy of resources. Thus use of the unstructured, or open-ended, interview appeared to be the most effective and efficient method in relation to these four criteria. Through the use of the unstructured interview, a fairly clear picture of a respondent's private definition of a situation could be obtained.

A more accurate means of studying client response to instructional development activities might have been through direct observation. This method of data collection, however, would not only have been costly in terms of time, but might also have been ineffective in yielding sufficient information. For example, in discussions with instructional developers, it was noted that many important decisions were made and interactions occurred in informal situations rather than in formal development meetings. Development meetings, or conferences between instructional developers and their clients for the purpose of planning and designing instruction, were not alway accessible for logistical or political reasons. By using the interview, however, more instructors who were clients of the instructional development agency were contacted than could have been observed. Moreover, a wider range of instructors were interviewed since those who had finished projects or who had dropped from projects were included along with those currently involved in projects. Finally, interview was essential to obtain subjective infomration about a situation from a respondent (McCall & Simmons, 1969; Richardson, Dohrenwend & Klein, 1965).

For the purpose of generating categories upon which to focus the main set of interviews, three university instructors were interviewed; one who had just begun work with the development agency, one who had nearly finished a project, and one who had completed a program/course which was currently offered at the university. The names of the initial three respondents were suggested by members of the instructional development staff of the agency being studied. The data from these interviews suggested categories to be explored and their possible relationship to one another.

The main sample of instructors was selected by sending a request for cooperation to seventy-six instructors who had worked with the campus development agency. Twenty-one instructors responded. Appointments were made with all twenty-one, beginning with those who were seen as having had maximum contact with the development process. Other names were then suggested by the respondents, sometimes unsolicited and sometimes in response to a description of a category needing expansion. Thirty-one instructors were interviewed in all. Their positions ranged from teaching assistant to full, tenured professor and included both those new to teaching and those with many years teaching experience.

Interviews were tape-recorded. Each instructor was assured of confidentiality prior to beginning the interview. It generally took between fifteen minutes to half an hour of conversation before instructors began to express their feelings about the instructional development experience. The interviews were started by asking the professors to explain their positions in the university and to describe the instructional development project in which they had been involved. As the conversations progressed, this led to their feelings about the projects, generally with little or no prompting. A total of thirty-one interviews, varying in length from forty-five minutes to two hours, were conducted before the data were considered sufficiently redundant to cease collection.

Analysis of Naturalistic Data

Before discussing the analysis of naturalistic data, it is important to understand the goal of this type of data analysis. Unlike quantitative research where the goal is to produce a replicable study, one in which two researchers working from the same data would arrive at the same conclusions, naturalistic inquiry is intended to produce a unique theory grounded in the situation or event under study. As Glaser and Strauss (1967) point out, the goal here is to "allow, with discipline, for some of the vagueness and flexibility that aid the creative generation of theory." (page 103)

Both sociologists and anthropologists explain the work of naturalistic inquiry as an attempt to "describe the social world studied so vividly that the reader, like the researcher, can literally see and hear its people ... " (Glaser & Strauss, 1969, page 228) Sociologists call this activity "grounded theory" while anthropologists use the term "ethnography." Spradley (1979), an anthropologist, defines the purpose of ethnography as "the entire process of discovering the meanings of one culture and communicating these meanings to people in another culture." (page 205) A simple, "omnibus" definition of culture given by Spradley and McCurdy in The Cultural Experience (1972) expands meaning to embrace what qualitative sociologists see as their realm of study: "culture as nearly everything that has been learned or produced by a group of people." (page 7)

The naturalistic data to be analyzed is very different from the type of data quantitative researchers collect. It generally consists of hundreds, even thousands, of pages of field notes or transcriptions of tape-recorded interviews. Moreover, data analysis in an ongoing process integrated with data collection. As Spradley and McCurdy (1972) explain,

> Analyzing your field notes cannot be left until after your last field session. After each interview or period of observation it is valuable to transcribe all you have learned into as complete a record as possible. (page 81)

The primary purpose of analysis is to discover "themes," topics or situations which occur and reoccur in your field notes or the conversation of your subjects. These themes are used to construct hypotheses or develop ideas about how your subjects define themselves, their activities, or the events or organizations in which they participate. While both sociologists and anthropologists follow this same general procedure, the intended outcomes for each are slightly different. Ethnographic analysis attempts to discover underlying cultural patterns, the ways in which people "take the chaotic jumble of stimuli they experience each day and reduce it to manageable terms." (Spradley & McCurdy, 1972, p.60) Sociological analysis aims at a more systematic method of theory building, at generating theory that is "integrated, consistent, plausible, close to the data --- and at the same time is in a form clear enough to be readily, if only partially, operationalized for testing in quantitative research." (Glaser & Strauss, 1967, page 103) The techniques of anthropology are more clearly defined and comprehensive than those of sociology. Knowledge of the analytical techniques of both fields is important to the naturalistic researcher.

Ethnographic Analysis. Anthropologists begin to limit the part of a cultural scene they will study by listing all topics, or domains, comprising their area of investigation. Each domain being studied is then analyzed acccording to categories and attributes. As Spradley & McCurdy (1972) explain,

> In every society there are shared ways people have learned to define their world. First, they learn some things

> are to be included in a category and others to be ignored. Then they learn which attributes are associated with each category and which are not. The ethnographer must discover both the categories and their respective attributes that are being used by those he studies. (page 71)

Discovering cultural categories begins with a search for different objects, people, or events being treated in a similar way by respondents. Categories are then arranged in a taxonomy with the broadest, most inclusive term being subdivided into more specific terms and these each further subdivided. For example, the category of "people who do instructional development" might be divided into subcategories that include instructional developers, teachers, media specialists, trainers, and program designers. Each of these subcategories might then in turn be divided into all the different types each subcategory includes.

While categories are developed by finding the terms for people, objects, or events they include, attributes are determined by looking for the contrast between categories. Spradley and McCurdy (1972) describe these as "the bits of information informants use to distinguish differences ... among related categories." (page 73) For instance, attributes of the category "people who do instructional development" are determined by examining the differences between all the kinds of people who, in any way, perform instructional development activities.

The Constant Comparative Method of Analysis. Glaser and Strauss (1976) have outlined a method of analyzing naturalistic data which combines the coding of data with the generation of theoretical ideas. This method, they explain, has four stages which operate simultaneously until analysis is complete. These stages are summarized below:

1. Comparing incidents applicable to each category. Analyst codes data into categories, comparing it with other data in the category to determine the full range of types comprising the category and the relation of the category to other categories.
2. Integrating categories and their properties. As coding continues, properties of categories emerge and become integrated in the developing definition of a situation.
3. Delimiting the theory. As the theory about how to define a situation develops, categories and their properties combine into higher level concepts and incidents are coded only if they add new aspects to the developing theory.

4. Writing theory. Using the categories, the concepts developed to explain the relationship among categories and their properties, and the notes of the researcher discussing the reasoning behind the concepts, the researcher can begin to develop the major themes of the theory to be presented in papers or books.

It should be remembered that the primary purpose of this method of collecting, analyzing and presenting data is to generate a unique theory grounded in the situation or event under study. The theory is then presented in narrative form using direct quotation as often as possible to support and clarify the reasoning behind the formation of the theory.

Application of Techniques to a Research Study. Once again using the study of how professors thought about instructional development, an illustration can be drawn showing the way in which naturalistic data can be analyzed. The original intent of this study was to provide a narrative reflecting instructors' perceptions of their work with a campus instructional development agency; however, as the data was examined, it became apparent that the emotional responses of instructors to the instructional development situation was more relevant to understanding their perceptions than the way in which they described development activities. Respondents had mastered instructional development jargon and described the same activities, often in the same terms, yet their descriptions varied depending upon how they felt about the development experience as a whole. While some instructors were enthusiatic about their experience, others expressed indifference and a third group were actively irritated. These reaction, which occurred over and over in the data, led to the development of a typology of instructors, the three main categories of which were labelled Believers, Skeptics, and Dropouts. The names arose from actual statements of those interviewed:

> They brought us through their process and now we are believers and converters.
>
> When I look back on the process, I'm skeptical of it. I'm not sure it was that much concrete help.
>
> We kept trying until we felt they had lost interest and then we just dropped out.

Having recognized this typology of instructors as basic to data analysis in the study, contrasts among the categories could then be examined. For example, looking at the differences between the two categories, Skeptics and Believers, it was found that the major theme separating the two was personal involvement. While all Believers who were interviewed mentioned this theme of personal involvement with their developer and the personal growth experiences that occurred as a result, none of those who expressed skepticism about development mentioned a personal relationship or personal changes.

Two other themes, need for a developer and impact on content, created additional clear contrasts between these two groups. For example, in the area of need for a developer, one Believer claimed,

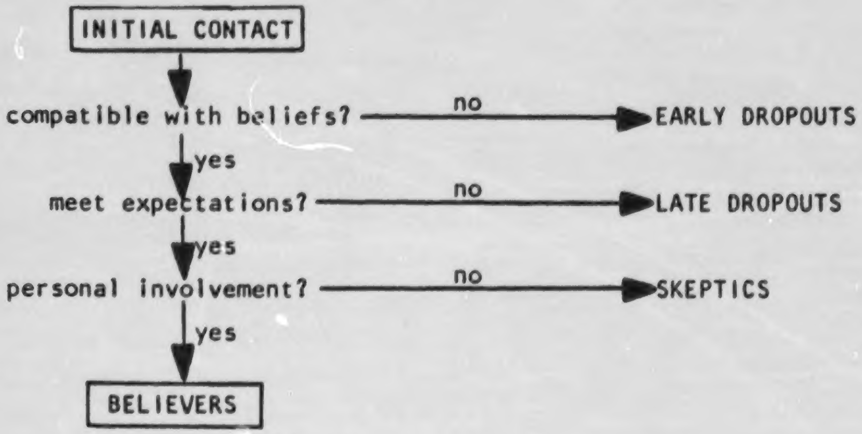
> If it had been left to me, I would never have done it --- never. That's a personality thing, no reflection on the process or the outcome. It's just what I know I cannot do.

In contrast, Skeptics said they would have done the work anyway, that they did not really need the help of a dveloper. Whereas Believers discussed a continuing need for development help from the Center, Skeptics were not interested in using the services of the Center again. One Skeptic was asked, "Would you go back?"

"I don't know as I have the energy," was his response. "It took a lot out of me. And the rewards are not all that clear."

This study can also provide an example of grounded theory. The theory that developed from the study had to do with how instructors became involved in the instructional development process. In summary, the theory is this. Starting with a group of university instructors, all of whom were exposed to somewhat the same initial experiences with instructional development, some completed the experience while others dropped out. Those who dropped out had specific expectations which were not met. Of those who finished projects, some were skeptical of the value of what they had done while others became Believers. The main difference between the two groups appeared to be the experience of personal growth and self-discovery by the Believers. It is postulated that when the appeal of instructional development activities, described by certain faculty members as personal growth, was combined with their susceptibility to the solutions offered to their instructional problems, Believers in the instructional development process were created.

Theory emerging from naturalistic data can sometimes be made more clear through the use of diagrams. The following diagram was constructed to clarify and summarize the theory outlined above.



One further illustration from this study might help to highlight the richness of a theory which uses quotations rather then statistics to support its construction. One Believer, describing his own personal growth as a result of interacting with a developer who, in the study, was called Peter, presented a warm a revealing statement.

> Peter is a great guy for educating you. He can educate you to yourself. He's a master of that. He can put you onto people who can make you discover yourself. And that's the way he did with this whole program and with me. He never said, "You should think this, you should read this, you should do this." What Peter would do would be very subtly introduce you to a situation that would require you to read something or do something or talk to someone and the next thing you know, you've changed. So you need someone like that. You need someone to have the ability to have you self-discover. You can do a certain amount of it on your own, but it will take you forever.

Use of Existing Research in Naturalistic Inquiry

Use of existing literature differs radically between quantitative research and naturalistic inquiry. The quantitative researcher begins a study by a thorough search of the literature, looking for information that is related in any way to his/her own investigation. This information is then reviewed and forms the basis for operationalizing variables and selecting a research design. Naturalistic inquiry, on the other hand, may begin with little or no awareness of the existing literature. This is to allow the researcher to observe with with no preconceived ideas of how things ought to be. When the investigation is complete, however, and the grounded theory begins to emerge, naturalistic researchers may turn to the literature to see how their theory fits within the framework of existing formal theory.

In the sample study mentioned earlier, a grounded theory of involvement in instructional development was developed from the data. The theory became clarified when the categories of Believer, Dropout, and Skeptic were identified and examined for their similarities and differences. This brought about the realization that instructors described development activities differently depending upon personal belief in their value. Belief, which was the vital concept in this study, is also a pivotal factor in social movement theory; therefore social movement theory was examined for its relationship to the grounded theory of this study. It was found that social movements models generally seem more appropriate to the study of instructional development on a national, rather than institutional level and of practioners rather than clients of instructional development. One model, however, seemed particularly applicable, the model developed by Hans Toch (1965). Toch described a four-step scheme of analysis of why people adopt certain beliefs. Simply stated, the four steps leading to adoption of a social movement by a member of society are: (1) the posing of a problem situation which, if it has an impact on an individual, gives rise to (2) a problem. This results in a search for plausible solutions. A person in this condition of (3) susceptibility may encounter a social movement which advocates certain beliefs. When these beliefs intersect with an individual's susceptiblity, he may succumb to the (4) appeal of the social movement and thus become an advocate.

This four-step scheme clearly seemed to apply to the emerging theory of involvement of this study. The problem situation is a system of higher education where faculty members, while expert in their content disciplines, are not trained to teach. This can give rise to the problem of some instructors, the need to improve their teaching methods. These instructors are susceptible to the message of instructional development, thus beginning development projects. The interaction of the susceptibility of some of these instructors with the appeal of the instructional development process as a solution to their problem may result in their becoming advocates. Appeal in this instance appears to be the personal involvement which some faculty members experience during the course of an instructional development project.

Once a clear analogy was articulated between the grounded theory of involvement and formal social movement theory, the properties of belief could be examined within the various delineated theories. Examining a grounded theory of instructional development from the framework of social movement theory brought a new perspective to the factor of belief. It was found that the survival of a reform movement such as instructional development operating within the legitimate structure of the institution depended upon participants. As McLaughlin (1969) maintains, "Belief demands participation and participation demands belief " (page 277) Therefore, it was postulated that faculty as believers in instructional development could be an issue of survival.

Faculty who are Believers become vocal advocates of the Center. Since they themselves feel a continuing need for the services of the Center, they argue for its continued existence. Development centers, which are likely to be low in the funding priorities of an institution, may need such support if they are to continue their existence. Without advocacy, the development unit may not survive in an institution even if it is effective.

Summary

Naturalistic inquiry, a research methodology just beginning to make an impact on educational investigation, contrasts with the more traditional experimental research in a number of ways. Quantitative researchers use carefully controlled conditions and statistical models to predict behavior while naturalistic inquiry observes behavior in its natural setting. Its goal is to understand a situation or event from the point of view of those involved in it. Drawing on strategies developed by sociologists and anthropologists, naturalistic researchers use observation and unstructured interview to provide them with data which is then analyzed for categories and recurring themes. Examining categories for similarities and differences and postulating relationships among themes, the naturalistic researcher a descriptive account intended to help the reader view the world they have studied as its inhabitants do.

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TITLE: Teacher Comment and Sex as Factors in
Continuing Motivation

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TEACHER COMMENT AND SEX AS FACTORS IN CONTINUING MOTIVATION

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Introduction

Historically, motivation of students has been considered to be an important element in the design of instructional materials. Suggestions for a motivation component in instruction generally include gaining and directing students' attention, arousing their curiosity, or establishing an expected outcome (Briggs, 1977; Dick & Carey, 1978; Gagne, 1977). Keller (1979) notes that, although instructional designers apply research-based principles for activating immediate student motivation and for reinforcement, the relationship between student continuing motivation and instructional design is not well understood. The generally accepted evidence of continuing motivation for a task has been when, at a later time, a student chooses to return to a similar task rather than to one that is different.

The effect of teacher evaluation on continuing motivation is one factor that may have important implications for the design of instructional materials (Hughes & Sullivan, Note 1). Several researchers (Harter, 1978; Maehr, 1976; Maehr & Stallings, 1972) have suggested that teacher evaluation of student performance may decrease a student's continuing motivation. This conclusion has been based largely on results of studies in which external rewards, such as money, tokens, or awards, improved the performance of students but reduced their return-to-task rate (Calder & Staw, 1973; Deci, 1971, 1972; Lepper, Greene, & Nisbett, 1973).

A common feature of studies of evaluation condition and continuing motivation is that subjects were not actually evaluated. Instead, even though students were told that their teachers would see the results of their performance, the teachers did not subsequently evaluate them in any way. Thus, the effects were judged on the basis of statements to students that the teacher would see or evaluate their papers, rather than on actual evaluation by teachers.

As Page (1958) demonstrated, evaluative comments by teachers on one task can affect subsequent achievement on another task of the same type. However, the effects of teacher evaluative comments have not been considered in studies of continuing motivation. Yet, there is evidence that positive feedback increases motivation as measured by student interest (Harackiewicz, 1979).

Teacher evaluation may have a differential effect on continuing motivation depending on sex of subject (Hughes & Sullivan, Note 1). Researchers (Deci, 1972; Deci, Cascio, & Krusell, 1975) have found that positive comments increased boys' motivation but not girls' motivation. Negative comments, on the other hand, have been found to decrease both boys' and girls' motivation.

The purpose of this study was to examine the effect of teachers' performance-based comments on the continuing motivation of boys and girls. Three performance levels were crossed with two evaluation conditions (score only, score and comment). The degree of positiveness of the comments was based on the level of student performance on the initial task. When given a choice of doing one of two tasks, subjects who chose the one similar to the initial activity were judged as having continuing motivation.

Method

Subjects

Two hundred and one (201) fifth-grade students from three suburban elementary schools participated in the study. Students were from an average socioeconomic level.

Materials

The initial activity was a moderately difficult word search. The word-search activity consisted of 12 word-search boxes with one animal name hidden in each box. Four word-search boxes and four animal names were given as a set. Students knew that each name was hidden in one of the four boxes, but they did not know which box contained which animal name. The animal word-search activity was piloted with approximately 50 fifth-grade students. Results indicated that scores typically are distributed in such a way that subjects can be divided into three performance levels (high, middle, low) of relatively equal size.

The task-option activities, which consisted of another word search and a task to create words, served as the choices used to measure continuing motivation. The order of activities was alternated in each set. They were administered the day after the initial word search. Return to the similar activity was interpreted as indicating continuing motivation.

Each activity contained the same 15 names of states. The word-search activity had the names hidden in one box of scrambled letters. Students were told to find and circle the 15 given names. For the create-a-word activity, students made four smaller words from each of the 15 larger words (e.g., Colorado: color, road, door, car). Each smaller word had to have a minimum of three letters.

The word-search and create-a-word activities were tested previously for degree of student preference (Hughes & Sullivan, Note 1). The word search was chosen by 67% of the 135 fifth-grade students in the sample. The task to create words was chosen by 33%. As is common in motivation studies, the preferred task also was used as the initial task.

Procedures

Classroom teachers were trained to administer the word-search and task-option activities. The activities were included as a part of the normal class procedures. The first day, teachers told students they would have 10 minutes to do an animal word search which would be graded.

The experimenter corrected the word-search activities and divided students into three groups by performance. Within each performance level, students were blocked by sex and were assigned randomly to one of two treatment conditions: comment or no comment. The classroom teachers wrote evaluative comments on papers of those students in the comment group. The performance level determined the comment. Teachers wrote "very good" for the top one-third, "good" for the middle one-third, and "not so good" for the lower one-third. Teachers did not write comments for the students in the no comment group. All students received a score on their papers.

On the following day, teachers returned the corrected word searches to students. Treatments were administered simultaneously within each classroom. After students checked their papers, they were given the option of working on another word-search activity or on the create-a-word task. Choosing to work on the word search was an indication of continuing motivation. Teachers told students they had 10 minutes to do only one of the two activities. Teachers emphasized that the activity would not be graded. Students saw both activities before choosing one to do.

Criterion Measure

The criterion measure consisted of a word-search activity similar to the initial one and a task (create-a-word) to make smaller words from larger words. As is the standard practice in continuing motivation research, return to the similar activity (in this case, the word search) indicates continuing motivation.

Design and Data Analysis

A 3 (performance level) x 2 (comment) x 2 (sex of subject) completely crossed factorial design was used. The proportion of subjects returning to a word-search activity as a measure of continuing motivation was analyzed with an analysis of variance. In addition, a measure of reading ability was available for all subjects. A complex chi square technique was used to analyze the frequency of return to task by reading level.

Results

The mean proportion of subjects returning to task is shown by performance level, treatment, and sex in Table 1. A 3x2x2 ANOVA yielded a significant interaction between sex and comment, $\underline{F}(1,200) = 4.283$, $\underline{p} < .05$. This interaction reflected a pattern by which boys who received comments returned to task more frequently (.78) than boys who did not receive comments (.64), whereas girls who received comments returned less frequently (.73) than girls not receiving comments (.82). No significant main effect differences occurred for sex or for comment.

Examination of the data reveals that the interaction was a function of the differential effect on boys and girls of three levels of comments. If boys scored in the top or middle one-third receiving a "very good" or "good" comment, the comment increased the return-to-task rate. If boys scored in the lower one-third receiving a "not so good" comment, there was no effect. With girls, on the other hand, if they did well, the comment did not effect the return rate. But, if girls scored in the middle or lower one-third, the comments decreased the return rate.

The mean proportion of subjects returning to task by reading levels is shown in Table 2. A significant difference in return-to-task rates by reading level was indicated by a $\chi^2=24.49$, $p<.0001$. An examination of the data reveals that students in the low reading level returned to task (.93) more often than students in the middle (.76) or high (.53) reading levels. In the low reading level, 54 of 58 students returned to task. In the middle reading level, 53 of 70 students and in the high reading level, 40 of 73 students returned to task.

Discussion

Results indicate that teachers' evaluative comments have a significant, but differential, effect on the continuing motivation of boys and girs. Boys who received teachers' comments returned to task more often and girls less often than their counterparts who did not receive comments. In contrast to this general pattern, the negative comment, "not so good", for boys and the positive comment, "very good", for girls had no apparent effect on the return rate.

This difference in the effects of the comments may partially reflect a more general differential pattern of boys and girls in achievement situations. Harter (1975a, 1975b) has found that boys have a greater desire than girls to solve challenging problems. In addition, there is evidence that boys will choose a challenging task, even if they previously failed it, whereas girls are more likely to stay with a successful or familiar task (Crandall & Rabson, 1960). An examination of the data for the no comment group shows a similar pattern. Boys tended to choose the more challenging task--that is, low performing boys returned to the same task and high performing boys chose the other. Girls, however, returned more often to the same task, whether they had succeeded or failed on the original one. Girls appeared less willing to take the risk of choosing an unfamiliar task.

The opposite pattern occurred for the boys and girls in the comment group. Girls no longer returned to task as often while boys returned more often. Past research indicates that teachers may use the same comment in different ways for boys and girls (Dweck, Davidson, Nelson, & Enna, 1978). It is possible, therefore, that the two sexes may react differently to the same comment. These researchers found that positive comments for boys were related to their ability while for girls, they were an indication of the teacher's attitude. With negative comments, however, the opposite occurred so that they referred to the girls' ability and for boys, reflected the teacher's attitude.

Positive feedback, however, appears to be an important factor in the continuing motivation of both sexes. Not only did the comment "very good" yield a higher return rate for boys, it also did not yield a lower rate for girls as did the other two comments. The positive comment "good" also resulted in a higher return rate for boys. Harter (1975a, 1975b) noted that girls appear to have a greater need for social approval before performing a task than do boys. These results indicate that girls may need the encouragement of a highly positive comment before they will return to a task, whereas boys will return with both a generally and a highly positive comment.

Another factor which appears to affect return-to-task rates is ability as indicated by reading level. The significant effect of reading level on return rates was most evident with low readers. Across the comment and no comment groups, 54 of 58 low readers returned to task. In nongraded situations such as this, Harter (1978) found that students who are given a choice will choose a task that is at an optimal difficulty level for them. The low readers who had already done poorly on the word-search activity may have chosen to return to a word search because they perceived it as being not extremely difficult.

What do these results mean for the design of instruction? The overall results do not support the suggestion in the literature that teacher evaluation reduces continuing motivation for a task. To the contrary, boys and girls returned to task at a rate greater than .50 under both forms of teacher evaluation. The data, however, do indicate that it may be appropriate to use teacher evaluative comments differentially in order to encourage continuing motivation. Because negative comments seem to reduce continuing motivation, perhaps they should be taken out of the evaluation realm. Comments which were encouraging rather than evaluative could be used with low performers to increase their return rates. Positive evaluative comments may continue to be used since they appear not to reduce continuing motivation. In addition, results suggest that careful sequencing of tasks and enroute practices is important for encouraging students to return to task as well as for mastering the task. Activities should be provided at different levels of difficulty so that the resulting sequence would provide for continuous success and a greater possibility of continuing motivation.

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Table 1

Mean Proportions of Subjects Returning To Task
By Performance Level, Sex, and Comment Treatment

Performance Level	Males		Females	
	Comment	No Comment	Comment	No Comment
Very Good	.72	.50	.82	.82
Good	.82	.62	.63	.77
Not So Good	.80	.81	.74	.87
Total	.78	.64	.73	.82

N = 201

Table 2

Mean Proportions and Frequencies of Subjects Returning To Task
By Reading Level

Reading Level	Return	No Return
High	.55 (40/73)	.45 (33/73)
Middle	.76 (53/70)	.24 (17/70)
Low	.93 (54/58)	.07 (4/58)

TITLE: The Effect of Learner Cognitive Style on Auditory Learning Via Time-Compressed Speech

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THE EFFECT OF LEARNER COGNITIVE STYLE ON AUDITORY LEARNING VIA TIME-COMPRESSED SPEECH

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ABSTRACT

The purpose of this study was to investigate the relationship between auditory learning via rate-controlled speech and the learner's relative degree of field dependence/independence. Research related to the cognitive style of FD/I suggests that the ability of FI's to impose structure upon information may facilitate the processing of auditory information to a greater degree than is possible for FD individuals in times of rapid information presentation. The population consisted of 72 students at the University of Pittsburgh. Materials used consisted of normal and compressed versions of the Dwyer Heart script and the related evaluation instruments. Ss were divided into three levels based on the cognitive style variable and assigned to normal rate or compressed treatment groups. After listening to their respective treatments, Ss were administered the four achievement tests. Two-way analysis of variance procedures were applied to the data to detect significant effects. Results of the study have implications for maximizing the effectiveness of compressed audio materials.

THE EFFECT OF LEARNER COGNITIVE STYLE ON AUDITORY LEARNING VIA TIME-COMPRESSED SPEECH

Introduction

The purpose of this study was to investigate the relationship between auditory learning via rate-controlled speech and the learners' relative degree of field dependence/independence. Considerable research has investigated the comprehension of verbal materials presented by means of compressed or rate-controlled speech (Duker, 1974). A comprehensive review of this research (Olson & Berry, 1982) indicated, however, that limited research has focused on the interaction of rate-controlled speech comprehension and various learner aptitudes or perceptual/cognitive styles. Such research would provide (1) a means whereby a clearer understanding of auditory information processing could be achieved, and (2) additional evidence to resolve much of the inconclusive research on compressed speech which has been reported previously.

Compressed Speech

In an everchanging society with an increasingly rapid pace, it becomes more important for an individual to acquire knowledge and information in the most efficient and expedient manner. This imperative is compounded by the fact that individuals learn at different rates. Since time spent in instruction is an important factor in maximizing instructional efficiency, technology has provided a means of altering recorded speech so that instructor or student may adjust the rate of spoken presentation to suit his needs. This technique has been generally referred to as rate controlled speech or "Compressed Speech," Silverstone (1974) described this method of rate control as the "...reproduction of an original recording in which the word-per-minute ratio is changed to a slower or faster rate of speech without eliminating the pitch or natural quality of the voice." In an earlier publication, Silverstone (1972) describes this technique as the process by which consonant sounds are maintained as the original production, vowel sounds are reduced and pauses are eliminated as often as possible.

Foulke (1968a), in a paper presented at the Perception of Language Conference at the University of Pittsburgh, identified two indices for the evaluation of compressed speech: comprehension and intelligibility. These two variables have been investigated extensively in the study of the effectiveness of compressed speech. Comprehension of compressed speech is the ability to extract knowledge and information from a given text that has been accelerated. Objective tests have usually been given to measure the amount of information which has been attained.

Intelligibility refers to the extent that one is able to repeat information which was presented or to discriminate what one has heard. Tests of intelligibility usually require the subject to repeat given words or to choose a word from a selection based on their perception of the speeded text.

Tests of comprehension involve two or more groups that listen to a text which has been compressed to various degrees and then complete a multiple choice test on the material presented. Comprehension studies have investigated variables related to speeded playback, various sampling methods and word rates ranging from 250 to 325 words per minute. Generally, studies have found no significant difference as far as comprehension of material is concerned (Foulke, 1966; 1967).

These findings have, however, been questioned in studies by Adelson (1975) and deHaan (1977). In a comprehensive study, Adelson (1975), utilized hour long lectures rather than short passages, presented at rates of 175 and 275 wpm. The researcher suggested that shorter passages such as those used by earlier researchers do not adequately assess a listener's overall comprehension. Findings of the study indicate that the length of stimulus materials is a critical factor. The traditional measures of intelligibility and comprehension were also investigated by deHaan (1977) in an attempt to determine if an individual's self-selected rate threshold could be used as a measure of either variable. Results indicated than an individual's threshold is an extremely reliable indicator of compressed speech intelligibility but not of comprehension.

Foulke (1968b) reported that, with word rates ranging from 125 to 400 words per minute, comprehension was found to be adequate until the word rate exceeded 250 words per minute. As the word rate rose higher, the level of comprehension decreases in an inverse proportion. Foulke hypothesized that adequate processing time is needed for perception of words in order for comprehension to occur. If processing time is reduced, a decrease in comprehension results. Lost processing time was indicated to be a contributing factor in the level of comprehension. Hausfeld (1981) presented strong evidence for a working memory processing limit of approximately 275 wpm.

One methodological problem inherent in much of this research work is that the researchers used a variety of recorded messages which did not take into account the specific learning objectives or tasks and the complexity of information. Consequently, little generalizability is possible from their findings. This need was voiced by Orr (1971) who called for the employment of reliable and valid tests of comprehension in this research. Adelson (1975) further confirmed the need for tested evaluation instruments as well as valid and reliable stimulus messages.

Foulke (1968a) indicates that in measuring comprehension, there are two groups of factors which must be taken into consideration: (1) organismic features and (2) characteristics of the signal. Organismic factors include age, sex, intelligence and previous experience with the subject. Characteristics of the signal are concerned with word rate, method of compression and rate of occurrence of the speech sounds.

Intelligence or mental aptitude of subjects using compressed speech has been investigated and it has been shown that there is no significant difference between high and low aptitude subject's comprehension of material at one third the compression of normal rate (Parker, 1971). This finding is supported by research that shows that not only is there no difference between high and low aptitude subject's comprehension at one third compression of normal speech, but also the subjects learned more efficiently at the faster speed (Sticht, 1971).

In comparing high and low aptitude subjects, the influence of speech rate on comprehension is greater than the signal degradation which might occur. This indicates that regardless of the listener's mental ability, other human factors have a greater effect on comprehension than factors that are of a technical nature (Sticht, 1970).

Cognitive Style: Field Dependence/Independence

Cognitive styles have been defined by Kogan (1971) as the individual variation in modes of "apprehending, storing, transforming and utilizing information." Ragan (1978) further stated that cognitive styles are "psychological dimensions" which reflect the individual differences for the manner of receiving, processing and utilizing information. Witkin, Moore, Goodenough and Cox (1977) described the characteristics of cognitive styles as: (1) cognitive styles deal with the "form" rather than "content" of cognitive activities, (2) cognitive styles are generally considered stable over time, and (3) cognitive styles are "bi-polar" unlike intelligence or other psychological variables.

One cognitive style which has attracted much research attention has been that of field dependence/independence, identified by Witkin, Oltman, Raskin and Karp (1971). Simplistically, field dependence/independence has been described as the extent to which an individual can disembed a figure from a ground. This perceptual aptitude is, however, indicative of a much more pervasive cognitive ability which enables the field independent individual to impose structure upon perceived information and then use this structure to more efficiently process and store the information. This perceptual ability has been documented extensively by Karp (1963) and Goodenough (1976). Generally, the factor of field dependence/independence is measured by either the Rod-and-Frame Test or one of a number of Embedded Figure Tests (Embedded Figures Test, Childrens Embedded Figures Test, Group Embedded Figures Test). All of these instruments rely upon the visual perceptual system and consequently have most frequently been employed in investigation of visual learning variables. Goodenough (1976), however, suggests the much broader application of these instruments.

Orientation of the Present Study

The general redundancy in language, identified by Shannon and Weaver (1949) suggests great similarities between the auditory perceptual field and the visual perceptual field. In listening to an auditory message, the perciever must separate out or disembed relevant from irrelevant information and then further restructure this information for storage. It would appear then, in terms of auditory learning, that the factor of FD/I would operate on the listener's ability to distinguish and organize the relevant auditory cues and terms. If this rationale is indeed accurate, then field independent individuals could be expected to demonstrate greater ability in imposing such a structure and hence, should perform better than field dependent individuals. When the rate of information presentation is increased, as in the case of compressed audio messages, this difference could be expected to increase even further. No research, to date, has investigated this aspect of comprehension on rate-compressed speech.

A second, yet related factor has been discussed in the literature on compressed speech, that of utilizing reliable and valid instruments for the evaluation of listener comprehension. Until the present, no standardized instruments have been developed, and those which had been developed represented a global measure of a variety of learning tasks. Work done by

Rhetts (1974) suggests that learning research should also focus on the specific learning task being presented. Such a charge, would imply that specific learning tasks, presented via auditory channels be evaluated using instruments designed to measure achievement of each of those specific tasks. For this reason, a part of the research and evaluation materials developed by Dwyer (1967, 1972) were employed in this investigation. The evaluation instruments incorporated in this package allow the researcher to evaluate learner achievement relative to four different learning tasks or objectives: drawing or spatially restructuring information, terminology or recall of specific information, identification or spatial analysis and comprehension or interrelating information. In addition, a total test measures overall achievement on all tasks. The use of such materials would seem to represent a more precise method of evaluating achievement or comprehension* of information via the auditory mode.

Method

The stimulus materials used in the study consisted of two audio tapes produced from the 2000 word instructional script on the human heart developed by Dwyer (1967, 1972). This script was recorded by a professional narrator at an average rate of 150 words per minute. The rate was selected as the normal or control rate because it is generally considered to be the average speed used by newscasters. A compressed version at 250 words per minute was subsequently produced by use of the Variable Speech Control Module

*Note: The term comprehension as used in previous research relating to compressed speech should not be confused with the term identifying the Comprehension Test developed by Dwyer. The term as used by Dwyer refers specifically to the ability to "use information to explain some other phenomenon" (Dwyer 1972) whereas, the general term "comprehension" refers to a more generalized ability which could interchangeably be called learning or achievement.

(VSC Corporation). Past research (Foulke 1968b) has concluded that a working threshold exists at or near this rate.

The five criterial tests developed by Dwyer (Drawing Test, Terminology Test, Identification Test, Comprehension Test and Total Test) to compliment the instructional script were employed as evaluation instruments. In addition, the Group Embedded Figures Test developed by Witkin et al (1971) was used to determine the relative degree of field dependence/independence.

The population for the study consisted of seventy-two graduate students at the University of Pittsburgh. Care was taken to exclude any individuals having had prior, formal training in medicine, physiology or anatomy as well as any subjects trained in Cardio-Pulmonary Resuscitation (CPR).

Based upon the results of Witkin's Group Embedded Figures Test, subjects were assigned to either the control (normal rate) or the experimental (compressed rate) groups using a stratified random sampling procedure. This factor represents a continuous variable, ranging from 0 to 18. Exact cutoffs for the extremes (high-field independent or low-field dependent) are not clear and are generally considered relative to the population being tested. Based upon previous research conducted on a similar population, cutoffs of 10 and 14 were established. Subjects falling at 10 or below were considered field dependent and subjects scoring at 14 or above were considered field independent. Since this factor is a continuous variable, it would also seem necessary to assess the ability of individuals falling between the cutoffs and consequently, this group, termed "indeterminate" was also included.

Groups of four students (two experimental and two control) were seated at a four carrel listening post and listened to their respective versions of the instructional script through individual head phones. Immediately following the audio presentation, each subject completed the four achievement tests.

Data collected were analyzed using a two-way analysis of variance procedure to compare the two experimental groups (compressed and normal) X three levels of the cognitive style variable (field dependent, indeterminate, field independent) for each criterial test. Where significant F-values were obtained, the Tukey B procedure for pairwise comparison was employed.

Findings

Subjects were distributed among the treatment groups and levels of the cognitive style variable as shown in Table 1.

Table 1

Distribution of Subjects by Treatment and Cognitive Style Score (FD, I, FI) N = 72

	Field Dependent	Indeterminate	Field Independent
Compressed Treatment	16	8	12
Normal Treatment	15	9	12

Two-way analysis of variance procedures were performed on the scores obtained from each of the four criterial tests, as well as the total test scores. The results of these analyses were:

> Drawing Test: A significant F-value of F=4.08, p=.0213 was produced for the treatments x cognitive style interaction. Multiple comparisons via the Tukey B procedure indicated that the field dependent-normal treatment was superior to both the field dependent-compressed and the indeterminate-normal groups.
>
> Terminology Test: A significant F-value for the main effect of treatment was found, F=13.90, p=.0004. Comparison of means showed that the indeterminate-normal group was superior to the indeterminate-compressed group and the field independent-normal group was superior to the field independent-compressed group.

Identification Test: Significant F-values for interaction F=3.26, p=.0447 and for treatment main effects F=7.83, p=.0067 were found. Comparison of the means produced a significant difference between the field independent-normal group and the field independent-compressed group, favoring the normal treatment.

Comprehension Test: A significant main effect for treatments was found, F=11.99, p=.0009. Pairwise comparisons showed the superiority of the field independent-normal group over both the field independent-compressed groups and the field dependent-compressed groups. The field dependent-normal group was also shown superior to the field dependent-compressed group.

Total Test: A significant main effect for treatments F=9.99, p=.0024 was produced for the overall test. Comparison of means indicated that both the field dependent-normal and the field independent-normal groups were superior to their respective compressed groups. The field independent-normal group was also found superior to the field dependent-compressed group.

All significant pairwise comparisons are summarized in Table 2.

Table 2

Summary of Significant Multiple Comparison Tests

Drawing Test:	FD-Normal > FD-Compressed
	FD-Normal > I-Normal
Terminology Test:	I-Normal > I-Compressed
	FI-Normal > FI-Compressed
Identification Test:	FI-Normal > FI-Compressed
Comprehension Test:	FI-Normal > FI-Compressed
	FI-Normal > FD-Compressed
	FD-Normal > FD-Compressed
Total Test:	FD-Normal > FD-Compressed
	FI-Normal > FI-Compressed
	FI-Normal > FD-Compressed

Discussion and Conclusions

Results showed a general superiority of the normal group (150 WPM) over the compressed group (250 WPM). Although some previous research (Foulke 1968b) found little drop in comprehension at rates of 250 WPM, the stimulus material was generally of less technical nature than that used in this study. The heart script contains a good deal of medical terminology, which in some cases is very similar. No doubt, some of the findings of superiority of the normal rate group could be attributed to this fact.

In terms of the factor of field dependence/independence, it was generally found that few differences existed between levels of the factor. Of particular interest however, is the data obtained from the Drawing Test and the Terminology Test. In the case of the Drawing Test, the FD-Normal group differed significantly from the FD-Compressed group in a positive direction. No difference of such magnitude was found in comparing the FI-Normal vs. the FI-Compressed groups. Such a finding would tend to indicate that in such a learning task as this represents, it is essential for FD individuals to receive the instruction in a slower manner. This is of further importance when we consider the fact that the FD-Normal group scored higher than the FI groups (although not to a significant extent). This finding lends support to the basic hypothesis of this study, that FD individuals may have greater difficulty imposing structure on information when it is presented at a more rapid rate. Constructing the heart diagram is a task which demands that the learner organize the presented information into a new array having specific spatial locations and organization.

In the case of the Terminology Test, a reversal in the above pattern was found. Significant separation of the FI groups occurred, whereas none occurred between the FD groups. This would imply that in a task such as this (to recall verbal terms) FI individuals must be provided with adequate time to process and store the information. In such an instance, when the information is presented in a relatively well-orangized or structured manner, the FI learner may attempt to impose his own, different structure, the result being the need for additional time to fully organize and store the information.

This hypothesis is tentative, however, and should be further investigated.

Based on the findings in this study, a number of conclusions can be drawn:

1. In general, all individuals, regardless of their respective level of field dependence/independence perform better when instruction is presented at normal (150 WPM) rates of speed, in learning tasks such as those represented by the Dwyer heart materials. This would imply that the threshold rate of approximately 250 WPM is not realistic for audio presentation of information of this technical level, complexity or length.

2. Field dependent individuals operate at a greater disadvantage than do field independents when completing a synthesis task such as the Drawing Test, via compressed audio. When, however, the instruction is presented via a normal rate of speed, field dependents achieve higher scores, possibly because the slower rate provides them with enough processing time to restructure the information from the auditory mode to a spatial structure.

3. Field independent individuals, when presented with an information recall task such as the Terminology Test, achieve differentially less under compressed presentation modes than do field dependent individuals.

The findings of this study strongly suggest that further research be conducted to confirm or disconfirm the utility of a 250 WPM threshold for presentation of compressed material. It is also apparent that research be continued relative to the instructional effectiveness of auditory/visual materials presented at increased rates up to and beyond the traditional threshold of 250 WPM with individuals of varying levels on the field dependence/independence continuum.

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TITLE: The Effects of Videotaped Instruction in Notetaking and the Recording of Notes on Retention of Aural Instruction

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The Effects of Videotaped Instruction in Notetakting and the Recording of Notes on Retention of Aural Instruction

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Running head: Notetaking and Retention

Submitted: December 1, 1982

Abstract

The effects of instruction in notetaking, the recording of notes, and sex of the notetaker on the retention of aurally presented information were examined. Subjects were 43 male and 61 female sixth grade students. Students were randomly assigned to experimental conditions: instructed notetakers, uninstructed notetakers, instructed non-notetakers, and uninstructed non-notetakers. Notetaking instruction consisted of a videotaped presentation designed to train students in paying attention, selecting main ideas, maintaining pace, and personalizing presented information. All treatment groups then heard a brief prose passage. Assessments composed of 24 possible points were conducted immediately, five days, and 30 days after the presentation of the instructional passage. Notes were not returned for review, nor was the instructional passage repeated during the follow-up assessments. Significant interactions were found between instruction in notetaking and the recording of notes, favoring instructed notetakers, and uninstructed non-notetakers. Significant interactions were also found between sex and notetaking, indicating that notetaking was beneficial for females, while detrimental for males.

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The Effects of Videotaped Instruction in Notetaking and Recording of Notes on Retention of Aural Instruction

Notetaking has been used by students as a study tool for many years. The value of notetaking seems widely accepted, but supporting research in the field of notetaking has been inconclusive (Ganske, 1981). Studies concerning the value of notetaking, or the conditions under which notetaking facilitates learning, have been characterized by inconsistent and often contradictory findings. Some researchers have shown significant outcomes in favor of notetaking (Barnett, Di Vesta, & Rogozinski, 1981; Bretzing & Kulhavy, 1979, 1981; DiVesta & Gray, 1972,1973; Howe, 1970; Weiland & Kingsbury, 1979), while others have not (Ash & Carlton, 1953; McLendon, 1958; Riley & Dyer, 1979).

Researchers supporting various notetaking procedures have suggested several facilitative aspects of notetaking. Successful notetaking procedures have been reported to increase attention to material, to create a more personally understandable version of the presented information, and to improve the integration of previously learned information with new information (Howe, 1974; Peper & Mayer, 1978; Weener, 1974). Notetaking strategies that consistently produce such effects would certainly be considered valuable.

A substantial body of research exists, however, which suggests that notetaking procedures do not yield consistent, predictable, positive effects. Several possible explanations for such inconsistencies have been offered. The variability in research findings may be partially attributed to individual differences such as experience, memory capacity, and motivational levels among learners (Carrier & Titus, 1979). Ladas (1980) reported that a failure to produce statistically significant differences does not necessarily discount the possibility of notetaking effects, noting that experimental oversights often preclude the discovery of such differences.

Problems associated with the operationalizing of definitions for notetaking have also been evident. In various studies, definitions of notetaking have ranged from simply providing an opportunity to record notes using personal strategies (Bentley, 1981) to to the application of previously instructed notetaking skills (Carrier & Titus, 1981). Notetaking activities have often been assumed by the researcher, when "notetaking" may encompass many different activities. For example, it is possible that many notetaking researchers have not found significant effects because experimental notetakers often employ inconsistent notetaking procedures (Howe, 1974), or supplant expected procedures with personal strategies (cf. Carlson, Kincaid, Lance, & Hodgson, 1976). The variability in notetaking procedures and the lack of verifiability of many learner-generated notetaking processes may confound predicted effects (cf. Ladas, 1980). If consistent procedures for notetaking are taught, and their use by students is verified, the resulting effects may be more systematically evaluated.

There are a number of additional considerations which need to be addressed. Previous notetaking studies have not adequately examined the functions and effects of formally recording versus not recording notes for presented information. It is possible that notetaking instruction may produce metacognitive or encoding format or schema changes, though not actually resulting in more efficient or accurate learning. In related studies, for example, instruction had no effect on eventual recall of criterion information, but produced written notes that were qualitatively (Robin, Fox, Martello, & Archable, 1977), structurally (Palmatier, 1971), or both qualitatively and structurally (Rickards & Friedman, 1978) superior to the notes produced by untrained notetakers. The effects of formal notetaking instruction versus learner generated notetaking strategies, as well as the role of opportunity to physically record information, warrant further study.

The influence of variables such as sex of student and associated verbal differences also may have masked notetaking effects (cf. Ladas, 1980). Notetaking, a process involving listening, information encoding, cognitive processing, and decoding information in written form, is largely a verbal activity. As a result, verbal skills are likely to influence the effectiveness of notetaking: students with good verbal skills may benefit more than their peers without well-developed verbal skills. Maccoby and Jacklin (1974) suggested that female superiority in verbally oriented tasks becomes evident at approximately the sixth grade level and continues throughout adulthood. If so, females may be expected to benefit more from notetaking than their male counterparts whose verbal skills are not as well developed.

Differences in the outcomes of notetaking studies may also have been related to the use of college students versus younger students as subjects in most studies. As noted in related studies (e.g., Carlson, et al., 1976), college students often possess skills which may override the value of subsequent learning strategy training, thereby confounding the effects of such attempts. Younger students, on the other hand, may be less likely to have already developed learning strategies. As a result, younger students may benefit more from explicit notetaking instruction than older, more experienced college-aged students.

Given the inconsistency of reported notetaking effects, the preponderance of both formal and informal notetaking procedures warrants consideration. Although various notetaking procedures are commonplace in applied settings, research-based evidence supporting particular components and techniques of notetaking instruction is scarce (Norton, 1981). Using non-databased referents, Laycock and Russel (1941) summarized the recommendations of 38 study manuals. While the summary concerned notetaking from text, many suggestions such as organizing material, summarizing important points, and using one's own words may apply equally well to notetaking from oral prose. Bretzing and Kulhavy (1979) further suggested that notetaking procedures which involve semantic encoding, such as using the student's own words in recording the information, tend to result in superior recall. Formal instructional research which includes such emphases, as well as control for the influence of sex of student and opportunity to record notes, may produce a more precise approach to the study of notetaking.

In the present study, the effects of instruction in notetaking and the recording of written notes on the retention of aural instruction by sixth grade male and female students were examined.

Method

Subjects

The subjects were 43 male and 61 female sixth grade students, the entire sixth grade population of a rural school district. The district was slightly above national norms for both socio-economic status and academic achievement. Although a greater number of students participated initially, only students who participated in all phases of the study were included for data analysis pruposes.

Notetaking Pretraining

Based on previous studies (Bretzing & Kulhavy, 1979; Carrier & Titus, 1981; Howe, 1974) as well as an examination of components commonly included by educators in notetaking training (Laycock & Russell, 1941), the instructional treatment focused on four major components: 1) attending to specific components of presented information, 2) strategies for selecting important ideas, 3) keeping pace with the rate of the information presented, and 4) using individual strategies to personalize the meaning of the presented information.

The pretraining consisted of the presentation of a videotape training exercise, and the completion by students of an accompanying worksheet during the presentation. The worksheet which accompanied the videotaped lesson provided space for students to record both reasons for taking notes and the four important notetaking concepts presented during the videotaped instruction. Sixth grade student moderators were chosen and trained as actors for the presentation, in order to maximize the attention paid by sixth-grade viewers. Students were informed as to the activities and skills to be included during the training session.

The first segment of the video instruction focused on a rationale for the learning and use of notetaking procedures: to increase attention, to help the students remember, and to improve grades in school. After the reasons for taking notes were presented, students were instructed to think of additional reasons for taking notes and to record such reasons on their worksheets. Student-generated reasons for notetaking included pleasing one's parents, making the teacher think you are interested, and staying out of trouble.

The second segment focused on the four recommended notetaking procedures. The first key point focused on how to pay close attention to the speaker. Students were reminded to listen carefully initially, since information not heard could not be remembered, and were advised to watch the speaker carefully, to note facial expressions, and to utilize physical gestural cues. Next, subjects were instructed in a procedure to identify important information. They were told to direct close attention to information written on the blackboard or otherwise emphasized by the speaker, a strategy identified by Locke (1977), and were advised not to record information which was already known. Students were instructed to be attentive to words which are likely to signal the importance of information, such as "always," "remember," "main," "important," and "principal." They were also instructed to direct specific attention to other speaker cues which may provide hints as to the importance of information. Students were instructed to evaluate the likelihood of a given bit of presented information being included as a tested item as one way to determine the importance of information.

Students were then instructed in how to use their own words in recording notes. Examples of what a speaker might say and how students might transcribe such information were given. Students were told to interrupt the speaker if they could not understand words the speaker used. The final point included in the presentation concerned how to keep pace with the presented information. Students were told to use abbreviations where possible to enable them to maintain pace with the presentation, and that any abbreviation which had meaning for them was appropriate. They were told that penmanship was not important during notetaking, provided they were able to decipher their own writing, and that if they experienced difficulty maintaining pace with the presentation they were to reevaluate the importance of the items they chose to record in the notes.

As a review, these four major points were illustrated graphically, while the student moderators summarized the information which had preceded.

At this point, students were informed by the student moderators that they were to take notes on their worksheets during the practice science lesson which followed. A videotaped practice lesson on light was then presented by an adult teacher, covering concepts such as vision, reflection, and luminous objects. A review pause, during which student moderators discussed the notes they had recorded during the lecture was embedded in the practice lesson. Upon completion of the presentation, the student moderators compared recorded information in order to demonstrate the types of content recorded during the presentation. The pretraining videotape concluded with a brief summary reviewing the reasons for taking notes, the recommended procedures for taking notes, and the benefits to be gained as a result of the use of proper notetaking procedures.

An audiotaped practice session was then presented, designed to provide students with experience in notetaking during fixed-rate presentations without visual cues. Students took notes during this session, using the worksheets as a guide. A question and answer session with the experimenter followed, allowing students to evaluate the importance of the information they had recorded.

Criterion Task and Assessment

The criterion task was an audiotaped presentation on butterflies and moths, approximately 10 minutes in duration. Although students at this age typically have a general awareness about this topic, the content and assessments included information and concepts which are not generally known, such as the difference between a cacoon and a chrysalis. The presentation was paced in accordance with the approximate normal speech rate of 150 words per minute (Riding, 1979).

The assessment consisted of a 24-point test, reflecting both factual recall, such as, "How many eyes does a caterpillar have?" and integration of parts of the presentation such as, "Why is the silken trail important to the caterpillar?" Test-retest reliability of the assessment was computed to be .77. All questions required constructed written responses, ranging from one word to brief two-to-four word phrases.

Design and Data Analysis

The design was a completely crossed 2x2x2 factorial design, with immediate, five-day, and 30-day repeated administrations of the criterion assessment. Two levels of pretraining instruction (instructed/uninstructed) were crossed with two levels of notetaking recording (notetakers/non-notetakers), and both factors were crossed with sex of subject.

Only subjects for whom data were obtained on each of the three assessments were included for the data analysis. However, cell sizes remained fairly consistent. Mean scores for each assessment were analyzed for differences. In addition, the content of the notes collected from notetaking groups was evaluated using two criteria emphasized by Nye (1978): number of words recorded, and number of tested items contained in the notes. Forgetting scores, the decline in scores from assessment to assessment, were also calculated and tested for mean score differences.

Procedures

Students were randomly assigned to four experimental combinations of the instruction and recording treatments.

Instructed notetakers. Students received the videotaped pretraining instruction, completed the worksheet, and participated in the practice session. The worksheets and notes from the practice session were collected. The students were provided with blank paper on which to record notes, and told to do so during the presentation which followed. Students were informed that they would be tested on the information covered in the taped instructional presentation. Notes were collected following the presentation, prior to the immediate test.

Uninstructed notetakers. While the treated groups received the notetaking pretraining, students in both uninstructed groups were told to read silently unrelated content from a book of their choice, a normal daily activity in the school in which the study took place. Prior to the presentation, students were given a blank sheet of paper and instructed to record notes using their own procedures during the criterion task. Students were also told that they would be tested on the information contained in the presentation. Notes were collected following the presentation, prior to the immediate test.

Instructed non-notetakers. Students received the notetaking pretraining instruction, completed the worksheet, and participated during the practice session. Worksheets and notes from the practice session were then collected, as was the case for all students receiving pretraining. The students were then told that they would listen to a brief presentation, that they could not take written notes, but that they should try to remember as much as possible. No paper or other recording aid was permitted. They were informed that they would be tested upon completion of the presentation.

Uninstructed non-notetakers. While the instructed groups received notetaking pretraining, students in this group were instructed to read silently from a book of their choice. They were told to listen carefully to the presentation, and that they would be tested on the content upon completion. No paper or other recording aids were permitted.

The treatments were administered concurrently in separate locations. All presentations were paced identically to control alloted time-on-task. The groups remained isolated while the criterion information was presented. Notes were collected immediately after the presentation was completed, and the criterion assessment was administered. Subjects were allowed 10 minutes to complete the test. The identical test was administered after a delay of five days, and again 30 days following the initial presentation. The criterion task was not repeated at these times, nor were notes returned for review at any time during the study.

A list of correct item responses was developed. When necessary, vague or equivocal responses were reviewed jointly. All student responses were evaluated using blind scoring procedures.

Results

The mean number of correct responses for each of the three assessments is contained in Table 1, and corresponding ANOVA source data are included in Table 2.

Insert Tables 1 and 2 about here

Instruction-by-Notetaking Interaction

As anticipated, there was a significant interaction between the recording of notes and instruction in notetaking for the immediate assessment, F (1,96) = 4.59, p .05. Students instructed in notetaking performed most effectively when permitted to record notes (X=10.46), and least effectively when the opportunity to record notes was denied (X=9.71). This pattern was reversed for uninstructed students, resulting in more effective performance for the non-notetaking group (X=12.64) than for the notetaking group (X=9.65). On the 5 day delayed assessment, this interaction was also significant, F (1,96) = 3.97, p .05, with mean test scores of 10.19 for the instructed notetakers and 8.38 for instructed non-notetakers, while uninstructed notetakers and uninstructed non-notetakers scored 8.85 and 10.25 respectively. A similar, though not statistically significant, interaction was found for the 30-day delayed assessment.

Notetaking-by-Sex of Student Interaction

A consistent interaction between sex of student and the recording of notes was also found for immediate, F (1,96) = 4.07, p .05, 5-day delayed, F (1,96) = 6.93, p .01, and 30-day assessments F (1,96) = 5.58, p .05. Males performed most effectively in non-notetaking groups, regardless of instruction. This pattern was different for females, who performed most effectively under notetaking conditions. On the immediate test, the performance pattern for males was characterized by mean scores of 9.12 for notetakers and 12.36 for non-notetakers while females obtained mean scores of 10.66 for notetakers and 10.32 for non-notetakers. The identical pattern emerged for the 5-day and 30 day delayed assessments.

Analysis of Recorded Notes

A comparison of the recorded notes (see Nye, 1978) indicated that instructed notetakers recorded 32% more total words and 28% more tested points than uninstructed notetakers. Instructed notetakers recorded an average of 100.00 words, while uninstructed notetakers recorded an average of 75.68 words, *F* (1,47) = 5.15, p .003. The difference for the number of tested items recorded was not statistically significant; instructed notetakers recorded an average of 9.54 tested points in their notes, while uninstructed notetakers recorded an average of only 7.44.

Seventy-seven percent more words were recorded by females than males. Females recorded an average of 106.19 words in their notes, while males recorded an average of 60.00. This difference was highly significant, *t*(49)=4.02, *p* .0001. Similarly, females recorded 73% more information contained on the criterion assessments than males, with an average of 10.19 tested items contained in the notes of females and 5.90 tested items contained in notes recorded by males, *t* (49) = 3.32, *p* .002.

Forgetting

A significant notetaking effect for forgetting scores was found between the immediate and the 5-day delayed assessments, F (1,96) = 5.88, p .05. Students who did not record notes during the presentation forgot significantly more criterion information during the five day retention period than those who recorded notes. No significant differences in forgetting scores were found between the 5-day delayed and the 30-day delayed, nor the immediate and the 30-day delayed assessments.

Discussion

The purpose of this study was to examine the effects of notetaking and instruction in notetaking on retention of aural instruction. The results indicated that both sex of student and the opportunity to record notes are important factors determining the effectiveness of notetaking instruction.

The interaction between instruction and notetaking favored uninstructed non-notetakers and instructed notetakers consistently across the three assessments. On each assessment, uninstructed non-notetakers obtained the highest mean recall scores. This finding provides support for an interference effect, as proposed by several researchers (Aiken, Thomas, & Shennum, 1975; Ash & Carlton, 1953; Bentley, 1981; Peters, 1972) who found notetaking to inhibit learning from fixed-rate presentations. The authors suggested that the rigidity of pacing of many presentations and the density of the information included in such presentations might be decremental factors in notetaking. They further implied that interference might be present in other forms of mediated instruction, such as audiotaped instruction, where the resulting burden on the notetaker is too great. It is likely that notetaking procedures will be of maximum value when either modifications are made in the pace of instructional presentations, or notetaking procedures are developed that reduce en-route interference. This instruction by notetaking interaction suggests that students may perform effectively when permitted to use personally derived strategies, but that if some formal strategy is to be used, students may perform best when both trained in the use of the strategy and encouraged to physically record information.

Correspondingly, a similar explanation may indicate why instructed non-notetakers performed less effectively than uninstructed non-notetakers. Perhaps the instructed non-notetaking students were mentally performing the same operations as notetakers, although prohibited from recording their mental notes. In such cases, students would not only need to apply externally imposed mental notetaking procedures, but also to remember and to continually revise previously encoded information throughout the duration of a presentation. They may also have attempted to mentally sort out important content while paying insufficient attention to the ongoing presentation. In effect, such simultaneous and cumulative demands may overload learners and create a form of learning interference. Uninstructed non-notetakers, on the other hand, were able to use self-generated procedures with no interference from an externally structured strategy, and as a result had reduced demands during the criterion presentation.

The interaction between the recording of notes and sex of the subject was consistent throughout the assessments, favoring female notetakers and male non-notetakers. Maccoby and Jacklin (1974), in a summary of research on sex differences, concluded that there are significant sex differences in verbal ability, favoring females, beginning at approximately the sixth grade level. The findings in this study seem to support such a verbal ability influence; females recorded significantly more words as well as more of the information which was subsequently tested. It may be that due to the demands of the verbally dominated task of notetaking, verbal superiority may make notetaking a more beneficial tool for females than males at this grade level. Perhaps certain levels or types of verbal skills involved in notetaking are prerequisites for successful use of the notetaking process; males at this age may not possess these skills, rendering the process less effective, or in some cases, detrimental. Further research may focus on the levels or types of the different verbal skills which are necessary to make notetaking helpful to students, and the feasibility of training students in the critical verbal skills needed to effectively encode and assimilate notes.

The absence of main effects for instruction and notetaking suggests that, like many other psychological and educational phenomena, effects are likely to be conditional. In addition to the instruction and recording dimensions included in the present study, factors such as student-generated learning strategies (Carlson et al., 1976), and the complexity of the learning task and age of the learners (Salomon & Clark, 1977) are likely to moderate the effectiveness of various notetaking instruction and recording procedures.

Increased instructional time and increased time spent in the practice of notetaking skills may make such treatments more powerful, thereby increasing the potential for obviating the effects of notetaking instruction. An examination of the means for instructed and uninstructed notetakers revealed that although the main effect was not significant, instructed notetakers obtained higher means than uninstructed notetakers on each assessment. This pattern was consistent for both males and females. Future research with temporally distributed instruction (Aiken, et al., 1975) and more opportunities to practice and develop notetaking skills may produce more reliable information on the role of instruction in notetaking per se.

It is also possible that the testing which followed the criterion task, in this and other studies, performed a function similar to the process of notetaking, thereby masking the importance of notetaking. Testing immediately after instruction may cue students to important ideas, and as a result, facilitate retention by serving a purpose identical to that of notetaking. Duchastel (1981) has demonstrated such an effect with constructed response tests similar to those used in this and other notetaking studies. Perhaps notetaking effects may be best examined after a longer interval has transpired between the presentation of information and the assessment of recall. In such instances, it may be more likely that notetaking would play a significant role in retention, especially in the absence of other forms of overt recording responses (Barnett, Di Vesta, & Rogozinski, 1981).

Further research in the field of notetaking is indicated in several areas. The specific components of effective notetaking need to be identified more clearly. The relative effects of different notetaking components in improving factual recall, inferential learning, and a variety of other types of short and long term learning are also needed. Length, complexity, and duration of the instructional task also loom as potential moderators of notetaking effects. In addition, the elimination of the initial assessment in favor of longer interval assessments would better indicate the effects of notetaking per se, both as a procedural control and a more realistic approximation of educational settings where immediate assessments are not generally obtained. Finally, additional research investigating levels of verbal skills in listening, processing, and writing, and how such skills interact with the density of the presentation content may provide information necessary to determine the point at which students may be expected to benefit from the notetaking process.

Notetaking procedures appear to have a great deal of intuitive appeal. However, a significant number of unanswered questions exist regarding the structure, components, task dependence, and learner characteristic considerations surrounding such procedures. With greater diligence and increased interest, notetaking may someday warrant the trust commonly invested in these strategies.

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Table 1

Mean Scores for Immediate, 5 Day Delayed, and 30 Day Delayed Assessments

		Instruction		No Instruction		
Test Position	Sex	Notes	No Notes	Notes	No Notes	Total
Immediate	Male	9.40	11.30	8.91	13.42	10.84
	Female	11.12	8.57	10.20	12.06	10.56
	Total	10.46	9.71	9.65	12.64	10.67
5 Day Delay	Male	8.70	9.60	7.64	11.25	9.35
	Female	11.12	7.50	9.73	9.50	9.52
	Total	10.19	8.38	8.85	10.25	9.45
30 Day Delay	Male	7.40	9.00	7.09	10.50	8.56
	Female	10.25	7.86	8.67	9.19	9.03
	Total	9.15	8.33	8.00	9.75	8.84

Note: Cell sizes ranged from 10 to 12 for males, and 14 to 16 for females.

Table 2

ANOVA Source Data for Immediate, 5-Day Delayed, and 30-Day Delayed Assessments

		Immediate		5-Day Delay		30-Day Delay	
Source	df	MS	F	MS	F	MS	F
Main Effects							
Instruction (I)	1	28.68	1.51	1.81	.12	.51	.04
Notetaking (N)	1	36.50	1.92	.52	.03	7.11	.54
Sex (S)	1	1.31	.07	.82	.05	6.02	.46
Interactions							
I X N	1	87.16	4.59*	62.68	3.97*	39.10	2.98
I X S	1	1.41	0.74	.00	.00	3.25	.25
N X S	1	77.32	4.07*	109.37	6.93**	73.32	5.58*
I X R X N	1	5.13	.27	.72	.05	1.91	.15
Error							
Within Cell	96	18.99		15.79		13.13	

* p .05

** p .01

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TITLE: Aptitude Treatment Interaction Research Has
Educational Value

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APTITUDE TREATMENT INTERACTION RESEARCH HAS EDUCATIONAL VALUE

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NOTE TO READERS:

In this paper the pronoun `his' will be used in its generic form. This writer agrees with another feminist who says, "My expository style relies heavily on the exemplary singular, and the construction "everybody...his" therefore comes up frequently. This 'his' is generic, and not gendered. 'His or her' becomes clumsy with repetition and suggests that 'his' alone elsewhere is masculine, which it isn't. 'Her' alone draws attention to itself and distracts from the topic at hand. 'Their' solves the problem neatly but substitutes another. 'Her' is bolder than I am ready for. 'One's' defeats the purpose of the construction, which is meant to be vivid and particular. 'It's' is too harsh a joke. Rather than play hob with the language, we feminists might adopt the position of pittying men for being forced to share their pronouns around."

Mary-Claire van Leunen, A Handbook for Scholars, New York: Knopf, 1978, pp. 4-5.

Aptitude Treatment Interaction Research Has Educational Value

As new educational methods and technologies have been developed, researchers have tested them against older methods of teaching. Some research has correlated teaching methods with measures of student aptitudes, finding that students may respond differently to a particular method depending on such variables as intelligence, learning style, or personality. These studies, often referred to as aptitude-treatment interaction (ATI) research, have been difficult to interpret at least partly because the findings of one researcher cannot be duplicated by another. For this reason, researchers like Snow (1976) have said that no educational value has come from the work.

Snow's comment seems to be unduly restrictive. There are surely a few consistent findings from ATI research that can be valuable as educational guidelines. One important conclusion is that, in general, any particular educational procedure used does not benefit equally both the good and the poor students. Another significant finding is that students charateristics are so diverse that consistent ATI results can only be anticipated when teacher and subject are held constant (Gillmore, 1981). This indicates that outcomes obtained with one teacher or software medium may not hold true for another. A number of studies, for instance, have shown that slower students do better with instructors who provide structure in the form of lectures, pictures, outlines, rules, etc. On the other hand, these structuring systems may disadvantage the better students.

The statistics most commonly used in ATI research plot students' test scores against the chosen aptitude measure or trait (anything from anxiety to learning style to intelligence). This produces a scatter diagram for a specific combination of student characteristic and teaching method. The nature of the distribution may be summarized in a regression line, which, when using intelligence as the aptitude measure, normally has a positive slope, meaning simply that, with that particular teaching method, the scholastically superior students do better than those with lower aptitude scores. When the slope of the line is steep, it shows that the brighter students have gained most, widening the difference between them and the slower students. A less steep line narrows the difference between the high and low students by raising scores for the scholastically poorer students but frequently lowering the scores for the brighter ones. Negative slopes are not common when using intelligence measures but do occur when using personality, motivation, or anxiety as the aptitude measure.

Teachers might use the average slope of the distribution to determine the overall effects of a

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teaching method for a specific class.

Need For the Study

There is a great number of good teaching procedures and media available today. Weil and Joyce (1978) advocated flexibility in the teacher's use of these. However not all are available or practical for many educational settings. Particularly in higher education, many professors, department chairpersons, and deans have never had an education course, may have developed poor teaching methods, and would find it difficult to change their habitual patterns. In too many cases faculty are assigned a block of time, a room with bolted down chairs, a hundred students to sit in the chairs, and a blackboard with chalk (one color). Even within these constraints there is a great deal that an innovative instructor can do.

It is the intent of this paper to organize the major findings of the ATI research in such a way as to help teachers combine this information with that in a methodology textbook so that they may have a better idea, not only of how to use a specific teaching technique or method, but also of how students with particular aptitudes may respond to this technique. To this end a summary model of ATI research results in presented in this paper.

Understanding the Effects of Teaching Methods

Many methodological texts describe how to execute a teaching method but seldom explain how learning outcomes may vary for different students. Nor do they share the concern of at least one researcher, who says: "it seems evident that it is not only possible to help a `natural' process like learning but it is also possible to destroy it" (Gustafsson, 1976, p. 80). A good text, as far as it goes, is McKeachie's (1978), written for beginning college teachers. He carefully defines the advantages of the methods discussed and how to match methods with learning objectives of the lesson. A similar text is Manual for College Teachers (Bernstein, 1976). The time has come when we need to add to our knowledge of how to teach and of how students learn. Our failure to do so is one of the major criticisms cited by Mackenzie, Eraut, and Jones (1970) as causing "a crisis in teaching".

Evaluation of Teaching

Regardless of teaching methodology, instructors in higher education need to be able to determine the effects that their teaching is having on the students. Some departments have systems for evaluating faculty, others have none, at least formally, but even at their best evaluations are often subjective, and items may not be worded in ways that are helpful in indicating possibilities for change.

Even when specific methods seem called for, the interpretation of what is meant may vary widely (McKeachie & Kulick, 1975). "Class discussion", for instance, is likely to mean different things to different instructors. Becoming "more organized" is a difficult suggestion to act upon, especially when peers or superiors are being critical. Also trying to identify a general ideal ignores the unique individuality of the instructor. The only true test of effectiveness is the student's progress (Hoyt & Cashin, 1977).

Organization of the Research

ATI research uses regression statistics to obtain the average slope of a set of test scores (y axis) plotted against whatever aptitude measure may be available (x axis). By evaluating changes in score distribution (slope of the line) that results from changes in teaching methods, types of examinations, classroom ambience, or other instructional approaches, individual instructors can monitor the effects of these different variables. Some of these variables are under the instructor's control and some may not be, but in either case, the teacher should be aware of what is happening.

Consideration of Moral Issues

The obvious question is: Why would anyone want to disadvantage any student or group of students since this is contrary to our educational philosophy? We know that students will learn regardless of what method we use to teach (Machlup, 1979 & Macneil, 1980), but the goal is to find the method that will benefit most of the students most of the time. The ideal way, of course, is to plan each student's program individually, that is, to provide some students with a lecture, some with group sessions, and others with programmed instruction, some with illustration and some without. The problem is that few of us have this sort of flexibility of facilities, equipment, and materials. Even if we did, our methods of testing the learning needs of students are weak, and college students seldom appreciate being told what classes to register for. Research indicates that, when students are left alone to make this kind of decision, they seldom made it to their best learning advantage (Cronbach & Snow, 1981 p. 447). Perhaps in the future more choices will be made availabe to students, and training will be provided to help students choose classes.

However, most of us have to deal with reality today, and there are usually no alternate ways for your students to take the courses that you are teaching. A more viable solution to the problem is to teach the students how to learn using your method. A number of learning-style studies show that students who can learn using several alternative styles generally do better in school than those who are confined to a single one (Lange, 1971). Salomon (1979) trained students to learn from visual displays, and Snow (1976) reports on a Dutch medical school (discussed later) in which he felt that the change in teaching method would not have caused some students grades to fall (as they did) if they had had previous training on how to learn from the new methods the school had adopted. Helping students to cope with the many different types of learning experience--whether on a one-to-one basis or by means of an introductory college course--seems to be the most tangible of the present solutions to the dilemma that we are facing of trying to help each student to work to the maximum of his ability.

There is so much that takes place in the classroom that we do not understand. There is also a lot of research that has been put on shelves because it did not prove some clear fact. ATI research has no clear facts, no answers, but it does have some very important ideas that should be available for teachers to examine and work with, just as teachers have other methods and techniques that are not proven. Using ATI research will not solve any problems but simply add a bit of information about how the teaching method of the individual teacher may be affecting the class as a whole.

Exactly what is the ideal regression line will depend on the individual situation. A class full of all 4.0 students may have a normal flat line, while a class of college freshmen many have a fairly wide range of aptitudes and therefore a fairly steep distribution. As long as a distribution remains positive, it is not likely that any student is disadvantaged or prevented from learning. Some students may not be given the advantage of being taught in a way that helps them most, and they therefore will not learn as much as they might, given a different teaching strategy. This is what is taking place all of the time in our classrooms now. Our understanding of the problem will not change the situation, but it will give us the option to use different teaching strategies in an attempt to find the method that does the most good.

Development of Model to Apply to Case Studies

Introduction

Even though a fair amount of ATI research has been generated, it has not been consolidated or published for use by educators. Snow (1976) felt that, although there were a few positive ATI findings, there was no general application for education.

Each Teacher His Own Researcher

One important conclusion from ATI research is that, in general, whatever educational procedure is used, it is not likely to benefit both the good and the poor students equally.

Another important conclusion is that variables are so numerous that consistent ATI findings can only be anticipated when teacher and subject are held constant (Gillmore, 1980). With this in mind it should be clear that it is impossible to write a guide containing a general set of rules that can be used for all teachers in all situations. The only fully reliable model would be the results of studies conducted by the individual teacher for his individual subject. ATI studies do not give answers, but they do provide a base, a starting point, for individual teachers to learn more about how their style and method of teaching effect the students under their tutelage. As educational standards improve we should not be satisfied with ignorance or naivete there is knowledge available, and guidelines can be developed by which we can examine the effects of our teaching methods on our students.

The purpose of this paper is to provide such guidelines so that teachers will be able to develop and apply the results of ATI research in their own classrooms. To do so requires a knowledge of simple statistical techniques, which I will explain in appendix B. The calculations are relatively simple, especially with our present-day pocket calculators.

The two basic variables used in ATI research are 1) a measure of aptitude and 2) a treatment, measured by the outcome of a post-test. Aptitude measures in ATI studies are varied. Intelligence is the one most commonly used, but other psychological aptitudes have been studied and will be included in the presentation. Treatments are the many different teaching methods and techniques that have been tested against the aptitude measures.

The following discussion, is a summary of research results. Here, I will limit my consideration to 1) those treatment variables that deal with older teenagers or adults, 2) those studies that use fairly simple or standard aptitude measures, and 3) those results that show some consistency after repeated trials and thus may be of value for the teacher.

Base Line Measures

Since the purpose of this paper is to show the results of various methods, it is appropriate for the classroom teacher to determine first how the teaching methods he now uses effect the class. This is done by making a scatter plot and regression line from a set of test scores and the aptitude measure to be used (See Appendix B). The teacher then needs to make a decision as to the desirability of the distribution shown: should the slope of the regression line be kept as it is, with no change in teaching procedures; should the slope be increased by encouraging the brighter students and thus increasing the difference between the slow and fast learners; or should the slope be decreased by giving the advantage to the less able students, decreasing the range of post-test scores, and running the risk of disadvantaging the better students? The knowledge of how students are performing may also lead an instructor to look for ways to individualize instruction if this can be done within the financial and administrative limits of the institution. Once a decision has been made, a teaching method or technique that matches both the desired distribution outcomes and the learning objectives (see McKeachie's check list p. 296) can be chosen.

Some institutions may have a direct or indirect policy statement that will determine what the desired regression slope should be. For instance, Snow (1976) reviews research done at a Dutch medical school where case studies in small group discussions had been adopted as the overall method. This type of format would encourage the better students, especially those with high analytical (fluid) ability. The study also found that students who were internally motivated or had a high internal locus of control had trouble participating in the groups and did not do as well. This type of philosophy for a professional school could very well be designed to weed out students who might not be suitable for the profession. In this case it is likely that students poor in analytical ability and those who were extreme individualists or introverts did not pass the course.

Aptitude Measures Available

In preparing the distribution data the teacher needs some measure of student ability. Schools usually have some such records, and when available on computer they are easy to obtain. Such records might include entrance examination scores or the results of special tests required by the major department. These are particularly valuable if minimal time has elapsed since the examinations were taken by the students. GPA scores, as mentioned earlier, are often overinflated by the student's choice of courses. Compiling specific averages for groups of courses such as hard sciences, mathematics, etc., may give a better aptitude measure to compare with the subject matter under consideration. There are also several short tests available that can be administered for the specific purpose of measuring abilities. They are expensive but may be worth using and may help to validate those measures already available.

Even though a teacher's primary concern is to increase cognitive learning, other variables are worth considering. It is possible to find a teaching method that produces the desired regression slope using intelligence as the independent variable, but the method may at the same time increase anxiety levels or encourages defensive behaviors which are not desirable. Knowledge of this problem along with the use of ATI research could help to make desirable adjustments to maximize the best overall teaching procedures for any particular situation.

Model

For the model used in this paper I will consolidate the relevant studies into three aptitude types: 1) Intelligence will include crystalline, fluid, and spatial abilities and field dependence/independence. 2) Motivation will include conformity, independence, defensive and constructive motivation, as well as locus of control. 3) The third group will include anxiety. Trait anxiety (long range behavioral pattern) is most commonly used although some tests combine trait and state anxiety in the same measuring tool, the latter representing immediate anxiety resulting from the present situation. For each of these three areas I will identify ways in which ATI research suggests that students with as the overall method. This type of format would encourage the better students, especially those with high analytical (fluid) ability. The study also found that students who were internally motivated or had a high internal locus of control had trouble participating in the groups and did not do as well. This type of philosophy for a professional school could very well be designed to weed out students who might not be suitable for the profession. In this case it is likely that students poor in analytical ability and those who were extreme individualists or introverts did not pass the course.

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Intelligence Used as Aptitude Measure

We will first look at intelligence, the first two columns of the model, and consider what methods and techniques can be used for a teacher who wishes to increase the benefit for the better students (steeper slope) and for the teacher who wishes to increase the benefit for the poorer students (flatter slope). Then we will look at a few studies in which the data are inconsistent to see what common threads might have some value in helping teachers make decisions about their use.

In considering the desired slope of the regression

Table 1

APTITUDE TREATMENT INTERACTION TRENDS

I= inconsistant or no action ↑= helps; ⇡ somewhat helpful ↓= hinders, puts to disadvantage	Aptitude G (crystaline = Gc, fluid=Gf, spatial=Gv)		Motivation		Anxiety	
	High field independent	Low field dependent Gf	conformity (high Ac) external loc	independent (high Ai) internal loc	high	low
Conformity, structure, rules	↓	↑	↑ Also good for defensive	↓	↑	
Teacher centeres/authoritarian	↓ I ↑ if hi Ax	↑	↑		↑	↑ if low G
Lecture	↑ in math ↓	↑				
Heavy use of words	↑	↓ esp. for Gc				
Low student responsibility & low student participation			↑	↓	↑	
Audio-Visual instead of verbal	I	↑				
Simulations, models	↓					
Punishment	↑ Girls		I	↑		
I. P. I. teacher guidance	↑ with guidance ↓	↑ best if hi Gf	↑	↑		
Permissive, low structure	↑	↓, I	↓	↑		
Student centered/democratic	↑ if low Ax				if low G ↑	↑ if hi G
Group discussion	↑ I	↓	↓			
High student responsibility & high participation			↑ if constructive	↑ if low Ai		↑
High student responsibility & low participation			↓	↑		
Rewards		↑	↑			
Explanations, meaning, theory		↑				
Simple pictures, picture stories	↓	↑				
Simple illustrations & algorithms	↕ for Gv only for Gc	↑				
Complex illustrations, linear syllogisms/word blocks	↑ especially for Gv	↓, I				
Eg-rul/inductive/discovery	↑, I	I, ⇡ ↓				
Rul-eg/deductive/expository	↑, I	↑ I for Rl. I for deduction				
Repetition, less elaboration	↓ EXTREME	↑				
Questions during and after lesson	↓, I	↑, I				
Advanced organizers	↕ dependent on complexity	↕ dependent on complexity				
Symbolic treatment	↓	↑				
Programmed instruction	I	↑		↑		
Audio tape with script	↓ EXTREME	↑				
Note taking	↑ normal speed ↓ fast	↓ normal speed ↑ fast				
Option to repeat	⇡ if hi Ax	⇡ if hi Ax	↑ esp. if defensive		↑	
Feedback/achievement cue			↑ esp. if defensive		↑	I

line, we need to bear in mind that there are many variables other than teaching procedures that can produce changes in it. One of these, and probably the most important, is the examinations the teacher uses. A hard examination is more likely to result in a steeper slope, and when the questions are more analytical rather than simple recall, the slope is also likely to be steeper. With this in mind, it is recommended that the examinations used for the teacher's experiment be the same, or the same style, as the examination used for the first check of the regression slope using current teaching methods (the control). This should avoid any major change being caused by this particular variable.

Advantaging the students with higher ability (steeper regression line).

When the better students have the advantage and are given the opportunity to demonstrate their fullest potential, the range of post-test scores increases. From the literature review we have found that the better students do not need structure. They do well in student-centered, democratic learning situations such as group discussion and buzz groups. These students are also able to learn from the presentations and questions of other students. Student panels and student reports should be helpful if each student is involved in the activity (see Table 2).

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Table 2

ATI studies comparing structured and unstructured classrooms with ability differences

researcher	treatment	high[1]	low[2]	comments
Ward (1956)	lecture		x	all women Ss
	group dis	x		
Wispe (1951)	directive		x	social relations
	permissive			
McKeachie (1961)	teach talk		x	psych, French, mathematics
	Sts. speak	x		
Calvin, Hoffman & Harden (1957)	authoritarian		x	groups-problem solving
	permissive	x		
Flanders (1965)	direct			7th & 8th grades
	indirect	x		
Herman, Patterfield, Dayton & Amersheck (1969)	teacher cent.	x	x	5th grade
		interest		
	pupil cent.	x		
	other results			
Guetzkow, Kelly McKeachie (1954)	recit & drill group tutorial-study	no interaction		psychology
McKeachie (1978 p. 35-36)	(also see McKeachie, 1963, 1964, 1968, 1975)			discussion best when objectives to change attitude
P.Peterson (1980)	lecture	x		9th grade public issues
	discussion		x	

---

[1] Best for students with higher ability

[2] Best for students with lower ability

Individually prescribed instruction (IPI) personalized instruction (PSI) (or Keller Plan), which may include PI, CAI, learning by objectives, or independent study, may be excellent for those bright students who are independently motivated or have a high internal locus of control (McKeachie & Kulick, 1975). VanDamme (1980) and Tennyson (1980), however, suggest that giving individual support and guidance increases the learning for those with external locus of control. Some of the many studies done on PI show a benefit to the poorer students and some show a benefit to the better student (Cronbach & Snow, 1981 p.178-187). The ability to stick to an individual plan of study seems to be more dependent on the student's personality then his inherent intelligence. The effects of programmed materials are more dependent on the techniques and quality with in the text. In order to separate individual learning programs the instructor needs to review the specific materials for techniques that give the advantage to the better students.

Regardless of the overall teaching method used, there are several techniques that give the advantage to the cbetter students. These can be used in lectures, text books, PI, CAI, and any other formal method of teaching. The better students benefit more from words rather than from illustrations and pictures. Text material that depends primarily on verbiage to communicate will be superior to those texts using pictorial diagrams, drawings, and illustrations. Photographs, which are designed to give an overall view of a situation may be appropriate, but detailed step by step pictures are not as easily understood by the better students as if the material were written out. Better students are usually high in verbal ability and can read faster and with more comprehension than the poorer students. Better students are able to evaluate and organize what they learn, and in some situations materials that are designed to help students in this way may in fact only confuse them (Table 3).

Table 3

ATI studies comparing techniques used in teaching with ability

researcher	treatment	high[1]	low[2]	comments
Marantz & Dowaliby (1973)	transcript	x		negative slope
	audio tape		x	for transcript + audio tape
Oakan, Wiener & Cromer (1971)	reading	x		
	audio		x	5th grade
	visual			
Koran & Koran (1980)	pic before tx			science
	after tx		x	text book
	no pictures	x		
Behr (1967)	verbal PI	x		7th grade
	figural PI		x	arithmetic
Groper (1965)	verbal (video)	x		physics
	visual (video)		x	
		hi pre-ach	low pre-ach	
Gagne & Gropper (1965)	verbal		x	8th grade
	visual	x		complex study
Mayer (1975)	verbal CAI	x		computer
	visual model		x	programming
		Gc	hi Gv	7th grade in
Gustafsson (1967)	verbal	x		
	figural		x	
Winn (1970 & 1980)	word block wd	x		
	word block pic		x	
Sternberg & Weil (1980)	horizontal	x		teaching Ss to
	spatial array		x	use both arrays

---

[1] Best for students with higher ability

[2] Best for students with lower ability

When extra explanations are left out, the better students will usually be able to supply them for themselves and their addition does not help. If the explanations are replaced with repetition of previous material, the better students are severely disadvantaged (see Table 3).

The findings regarding feedback and encouragement are not as clear for scholastic ability studies as for personality studies. There is some indication that brighter students do better if they are told that they are doing poorly (Means & Means, 1971). However, personality and anxiety levels seem to play a bigger role in this area than does feedback alone. These considerations will be covered later.

Note taking is usually appropriate in the normal classroom situation or for taped lecture material. Students who have a good memory will be helped by note taking, and their long term recall will be greatly improved (Berliner, 1971 & 1973). Although Peters (1972) questions the value in note-taking for anyone, he would agree that it is the least harmful to the better students (Table 4).

Table 4

ATI Studies Comparing Meaning, Questions, and Note-taking with Ability.

researcher	treatment	high[1]	low[2]	comments
Berliner (1971 & 1972)	note taking	x		college st. audio tapes
	questions		x	
	pay attention		x	
Peters (1972)	note-taking			
	listening alone	?	x	audio tape
DiVesta & Gray (1971)	note-taking	x	?	30 minute tapes
	no notes		x	
Edgerton (1958)	no meaning	x		military
	meaning		x	
Rohwer, Raines Eoff, & Wagner (no date)	elaboration	x		repetition harmful to high pre-test Ss.
	repetition		x	
Edgerton (1956)	theory first	reasoning x		military weather
	technique 1st	verbal x		
Depauli & Parker (1969)	hands on	x		navy sonar training
	explanation "trainer"		x	
Leith & McHugh (1966)	no meaning	x		all Men anthropology
	meaning 1st			
	meaning mid		x	
Shavelson, Berliner, Ravitch & Loeding (1974)	no questions	x		neg. regression on high order questions
	high order questions		x	

---

[1] Best for students with higher ability

[2] Best for students with lower ability

In general, then, the performance of the better students can be enhanced by choosing teaching methods that are less structured, and give more opportunity for sharing and exchanging information with other student as well as with the teacher, by techniques that help: an increase dependence on verbiage rather than simple pictorial explanatory material and avoidance of over use of explanations.

Finally let me say something about the inductive/deductive, expository/discovery methods of teaching. Here the literature is very contradictory: several studies have shown fairly strong results in one direction while others show strong results in exactly the opposite way. It seem reasonable that if a teacher were to use one of these techniques the results could be replicated using the procedure again by that teacher. This is an area in which there is less guidance from the literature, but it may be worth trying. Table 5 gives some information about the studies that have been done.

Table 5

Studies comparing inductive/deductive teaching with ability

researcher	variable	high[1]	low[2]	comments
Carry (1967)	deductive		x	geometry
	inductive	x		
Eastman (1972)	deductive	x		geometry
	inductive		x	
Thomas & Snider (1969)	didactic		x	8th grade history
	discovery	x		
Bakikian (1971)	expository		x	8th grade science
	exp+ lab	x	x	
	discovery	boysx		

---

[1] Best for students with higher ability

[2] Best for students with lower ability

Advantaging the students with lower ability (flatter regression line).

Although I have followed common practice in referring to a student's scholastic ability as "intelligence", this may be misleading. As used statistically, intelligence is merely what "intelligence tests" measure. There are three different types of general abilities: crystalline, fluid (analytical), and visual (spatial).

Many of the modern aptitude tests given to college students--SAT, MAT, GRE, etc.--test primarily for crystalline ability. Similarly, both high school and undergraduate college courses usually require the student to have high crystalline ability in order to do well. Most ATI studies also concentrate on crystalline ability for this reason "ability" in Tables 2, 3, 4, and 5 is not seperated into its three componesnts, and unless otherwise stated the reader can assume that students classified as "high" are primarily high in crystalline ability, while those classified as "low" are low in crystalline ability but may be either high or low in fluid or visual ability.

Students who are low in crystalline ability but high in fluid ability can usually cope with a classroom situation that is geared primarily to crystalline achievement, but they will have lower GPA or test scores than their true intelligence (general ability). When the teaching style is changed in such a way as to engage their fluid or visual abilities, they can naturally do better work. This needs to be borne in mind when this paper refers to students with lower (crystalline) intelligence.

Snow (1976) reported on studies that attempted to separate the three types of abilities, but the results were not significant enough to be of much value to the classroom teacher.

Poorer students benefit from structure. Studies indicate (see Table 2) that lecture, directive teaching, and a more "authoritarian" style of teaching tend to help the poorer students. They seem to do better "when more of the intellectual work is done for them" (Cronbach & Snow, 1981, p.503). Group discussions are not as beneficial for the poorer students, but when they are needed in order to meet the course objectives, the more structured they are, the greater the chances for benefiting the poorer student.

According to Cronbach and Snow (1981, p.504): "Procedures that reduce the intellectual demand often reduce the differences between the Highs and Lows". Thus poor students benefit most from materials that help them organize what must be learned. Any visual, pictorial, or graphic presentation, if not complicated, should be an advantage to the poorer students. Explanations of the theory, principles, and concepts behind a procedure or set of principles will help the poorer students understand and remember the material. Although there has not been as much research about repetition, there seems to be no disadvantage in repetition, as there may be for the better students (Table 4).

Since in general many poorer students have more difficulty with reading, visual materials are useful in helping them learn. In the same way audio tapes may help and using both audio tapes and transcripts of the lesson together may be especially helpful for a slow reader (as it is very detrimental to the fast reader).

Note-taking is not recommended for the poorer students except when the lecture (or audio tape) is given rapidly. All of the researchers cited in Table 4, put readings on audio tape and conducted the treatment using this rather artificial form of instruction in an attempt to remove the variables with the instructor's mode of delivery.

Two used five-minute taped readings and the other, thirty minute lessons. Although the research was very well controlled using these methods, I wonder how realistic it is to expect students to retain factual information given in one-and-a-half to two-hour lecture periods. Divesta & Gray (1971) were also concerned about the unrealistic time frames, but in a laboratory setting was unable to extend it more then the thirty minutes used in their study. Their results however represented stronger relationships at least for the low students than did the two studies using the five minute tapes.

Summary-Scholastic Ability

Where does this leave the teacher who is unable to split the class into two or three parts? According to ATI studies almost everything that is done will help some students more than others, and it may even disadvantage some. We don't know enough to be able to control or even identify that point at which the most students benefit the most. However by repeated experiments and comparison of the resulting regression lines the individual teacher should have a better idea as to how the teaching styles chosen have effected student performance.

Motivation and Anxiety Used as Aptitude Measure

For innovative teachers who want a better understanding of their students I will consider some ATI studies that use aptitude in its broader definition. These are identified in the second and third vertical columns of the model. We all know that even the brightest student can do poorly scholastically for all sorts of reasons, most of which are very difficult to measure. Motivation is of major importance at all levels of education. Anxiety may be a factor related to or separate from motivation, and it is of particular interest in highly competitive and professional schools (which are the setting for many of the case studies used in this paper). Personality also influences one's ability to learn, but this introduces a wide field beyond the purview of this paper. Here I will report on only a few studies which have used locus of control, a personality trait, in ways that are similar to and overlap motivation.

Once we consider any of these broader aptitudes we find that the tools that we have to measure both the aptitude and the results of the learning process are less reliable. ATI research uses several different measures which may or may not have similar implications. Findings in this area should all be considered weak; their use would certainly be questioned by a critic looking for hard facts.

These other abilities are so important, however, that we do not dare to overlook them in considering the effects of any teaching method. If students believe that a different teaching method does not provide them with as good an education as they were getting in a previous class or that the work is harder, they may react with anger (McKeachie 1963). Such a situation, may be difficult to deal with, but the appropriate solution does not lie in hiding behind the old cliche that ignorance is bliss. A teacher's classroom behavior affects the student in many ways, whether these effects are known or not. Learning is only one effect, and its results are generally clear. The more that is known about the other effects, the better off both the teacher and the majority of the students will be. The objective is not simply, teacher popularity. No teacher is going to be liked by all students no matter what. But education is more than learning, and we need to be as aware as possible of the effects of various teaching methods on total student development.

Studies of these nonintelligence effects are expensive and somewhat time consuming, and reliable measures are scarce. Many such measures are based on questionnaires to assess students' likes, dislikes, and personal preferences. Each teacher needs to decide how to administer the form in a way that is least threatening to the students, and so that it may provide the most valuable information. Administering these diagnostic inventories without any identification would be the most certain way to insure anonymity, but then it would be difficult to do ATI studies with them. Having another teacher administer the questionnaire and even renumber matching pairs before returning them to the researcher would be another way to assure total anonymity. Usually these methods are more extreme than is necessary, and if the students are given some benefit by learning how they can study better or gaining some insight into their own personalities, they are more likely to be willing to use code numbers that could conceivably be used against them. The time of day, other events of the day, and the amount of time needed to take the test need to be considered carefully in an attempt to gain the confidence of the students.

As mentioned earlier ATI studies have used a number of different measures. In the model these have been combined into what we will call motivation. One tool used to measure traits in this area is the California Psychological Inventory (CPI), which has scales that claim to measure a) sociability, self-assurance, and dominance; b) responsibility, self control, and tolerance; c) achievement potential and intellectual efficiency and; d) intellectual interest modes. This is a self administered questionnaire that takes forty five minutes to one hour to administer (C. P. Press, 1982). In addition Flanders (1965) has a scale that measures dependency, and the Edwards questionnaire by Bar-Yam can be interpreted as measuring defensive coping mechanisms (Cronbach & Snow, 1981, p.446). J. B. Rotter (1966) provides a questionnaire that is a simple personality test for locus of control,a characteristic that is similar to "independent/conforming" motivational styles.

Anxiety measures can be divided into trait anxiety and state anxiety (see definition at the beginning of this section). The later is less stable and therefore a less reliable measure. One anxiety test commonly used is the Taylor Anxiety test. Another is the State-Trait Anxiety inventory (STAI), which is a self-evaluation type of inventory.

Methods and Techniques that may help conforming students or those who have an external locus of control.

In this section when "helping" or"advantaging" is mentioned it means aiding the student to learn more as reflected in the results of a cognitive examination. Where likes or dislikes are involved, this will be specifically stated.

Students who are motivated by achievement-conformity (Ac) or have an external locus of control do much better in a controlled, teacher-centered environment. These students are usually cooperative types, those who find security in a traditional setting. Defensive students also do much better in a controlled environment where it is easier to anticipate outcomes (this may just be one of several ways to deal with anxiety). Some of these students also have a need for affiliation (McKeachie, 1961, 1962 & 1978), which seems to be satisfied by being the good, conforming, front-row student. Table 6 lists the researcher who have contributed to this area of ATI studies.

Table 6

ATI Studies Comparing Teaching Methods with Motivational Traits

researcher	treatment	Ac Ex. LOC	Ai In. LOC	comments
Domino (1971)	follow text	x	x	100 students of extreme scores for Ac & Ai. college Ss.
	structure	x		
	independent responsibility		x	
	student partic.		x	
McKeachie (1968)	less structured	x		college psychology
	direct		x	
P.Peterson (1976)	hi structure	x		
	low structure		x	
Horak (1980)	hi structure	x		locus of cont. student teachers
	low structure		x	
McLedd (1981)	hi teacher guide	x		locus of cont.
	group instruction		x	
VanDamme (1980)	PI with guide	x		college freshmen
	PI alone		x	
Tennyson (1980)	CAI with fd bk	x	x	high school
	CAI alone			
Reiser (1980)	punishment		x	grade changes for turning in papers early or late. LOC.
	rewards	x		

---

[1] Achievement by conformity and external locus of control

[2] Achievement by independence and internal locus of control

Methods and Techniques That May Help Students Who Are Independently Motivated or Have an Internal Locus of Control (LOC)

Group activity and a more permissive classroom style give the independent student a chance to question and explore his own ideas and thoughts about the subject matter. When anxiety is not high (see next section on anxiety) these students are able to take a large amount of responsibility for their education and are usually willing to participate in classroom activities. If anxious, they still can take responsibility , but the demand for participation needs to be low. These are the same students who may respond well to most types of programmed individual work whether structured (as PI or CAI) or unstructured (as IPI or PSI). Interestingly, these students may need a little negative feedback or even punishment in order to keep them doing their best work and on the task assigned (Table 6).

Methods to Help Students Who Have High Anxiety

"In many situations anxiety seems to be detrimental to learning or to performance on tests, but the findings are inconsistent. The mechanisms by which anxiety may influence learning and performance have not been clarified." (McKeachie & Kulick, 1975 p. 189). In table 6 defensive behavior has been included with conformity since this is the way it has been used in most of the studies. However Cronbach & Snow (1981, p. 446) suggest that both defensive behaviors and constructive behavior may be the individual's habitual way of dealing with anxiety. They also suggest that a poor self concept may cause anxiety. Whatever the cause, most of the research in this area indicates that in order to help students who have high anxiety the teacher should provide them with more structure and fewer demands for personal involvement. Defensive students also need to be dealt with in this manner. Many of these studies included several other measures besides anxiety and they all indicate that even though the student may be bright or independently motivated anxiety override these aptitudes , and structure is what will be the most beneficial (Table 7).

Table 7

ATI Studies Comparing Classroom Domination and Anxiety

researcher	helps hi Ax	helps low Ax	treatment
Domino (1971)	x		structure
		x	Ss domination
		x	ind. demands
Domino (1974)	x		teacher centered
		x	student participation
Dowabily & Schumer (1973)	x		teacher centered
		x	student centered

Helping students with low anxiety is not so clear. Some studies have assumed it to be important and have tested for it independently. Others have combined it with other variables, and these may have influenced the results. As might be expected the literature indicates that student-centered and independent participation should help the low anxiety student.

Conclusions

There is no guarantee that any teacher can repeat the general direction of ATI findings. However this synopsis and the use of table 3-1 should provide a good starting point. If a teacher finds, for instance that structure, as he perceives it, does not produce the effects suggested by the model then he should try other techniques which are related to structure, but which may have different practical application.

It is my theory that some teachers will not be able to change the slope of the regression line very much. Some teachers may find it easy to move in one direction and not in the other. This should not be interpreted as a failure but rather as a step toward better understanding of self on the part of the individual teacher--"self" meaning one cell, so to speak, in the body of educational endeavors of which we are all a part.

In the next section I will discuss how the model has been used in the classroom in several different case studies. Appendix B demonstrates the statistical techniques used in producing a regression line.

Applicataion In The Classroom

In order to illustrate how the model can be used in the actual classroom, case studies are being collected in which it has been applied. Although the model is applicable to ;any higher educational setting, the case studies are from a school of nursing in which nursing instructors applied the model to the didactic portion of their course. Most of the classes ranged from forty to fifty students and an experimental or control consisted of a tolat of six or more hours of lecture and at least eighteen test idems.

My hypothesis is that at least some individual teachers will be able to change regression slopes for their classes to some degree and in a predictable way. Several colleagues have agreeed to test this hypothesis by deliberatly changing their teaching techniques in the course of a single semester so that students performance can be measured using the same students taught by the same teacher in the same course (though obviously with different but related content), and with only the teaching method as a significant variable. The experimenters have been asked to use the finding summarized in the model in order to determine which method and techniques to use. The McKeachie (1978) text, Tips For the Beginning College Teacher, is available as a source of information on how to carry out these methods and techniques.

Aptitude measures used as a base will be the student GPA's and science GPA's obtained from student records available to faculty through a computer terminal. The institution in which the study is being conducted does not require SAT's or other tests for admission, so the results of these are not available. At the end of the study an "Inference" test and a learning style test will be given to searach for other corrolations.

All participating teachers are female nursing instructors. Each has volunteered and shown an interest in knowing how she affects her class and is willing to see whether she can manipulate regression lines by changing her teaching methods. The teachers range from four to ten years of teaching experience and rank from instructor to associate professor. They all either have an Masters of Education degree or a doctorate. Three of the case studies are still in progress at the time of the writing of this paper and will not be reported on.

For the experiment each teacher will teach the same group of students for three blocks of lessons, each of which will be followed by a post-test. In the first block she will teach in her own "normal" way. In the second block she will use as many methods and techniques from the model as are feasible for the purpose of the increasing the slope of the score distribution. In the third block she will similarly use those methods that are designed to decrease the slope of the line.

The thrust of ATI research tell us that a single teaching method helps some students at the expense of others. The design of this experiment is intended to test this thesis in a balanced way that will spread the gains and the losses equally over the whole student group, so that no individual is disadvantaged by the experiment itself. Teachers in the institution involved are free to choose their own teaching procedures and, by agreement with the Research Committee of the school, the students will not be told of the experiment. Emphasis is placed on the individuals teachers interpretation of the ATI research and their discription of the teaching method used.

Anticipated Outcomes

It is evident from data already collected that not all teachers will be able to change the slope of the distribution in the same way. Inflexible teachers may not be able to change at all no matter what procedure they use. Others may define an activity as one that should move the regression line in one direction, but then may discover that it actually moves it in the other, producing the opposite effect from the one intended. It is also anticipated that teachers who are normally structured will find it more difficult to be unstructured, in order to increase the slope, than to be overtly structured, and vice versa.

Early Samples of Application

Early in the development of the model a colleague of the author was discouraged from repeated poor peer and student evaluation of her classroom methods. Each of the criticisms indicated that the presentations needed to be better organized. Rather than asking her to participate in an experiment she was simply offered assistance from the ATI model, trying to identify those techniques which had the effects of order and organization.

The control, base line regression indeed verified that there was a problem. The scatter diagram and the regression line indicated a wide distribution of scores and the corrolation was .2. The regression line had little significance. This meant that there was little or no relationship between the students GPA and the score they were getting on her examinations. It also was known that the GPA's for the school were not a true reflection of the students ability since it is common practice to take course simply to raise the score to meet entrance requirements into the major.

The instructor hand made transparencies which outlined the topic being discussed and wrote out key words. The individual made it well known to fellow faculty, and the deen that she was activily working to improve her teaching. The results were not incouraging. The corrolation after the experimental teaching was .18, even lower than before. The reasons for this was not discussed with the instructor but her transparencies, were hand written in letters too small to be clearly seen by a class. A couple of students reported that the teacher conducted class in the usually non-directed manor until nearly the end that then quickly rushed through the transparencies, not providing adaquate time for the students to copy it into their notes.

This is a case of ATI failing to work but perhaps not because of any fault of itself. No tool is any better than the workman holding it, and in this case it would seem that the motivation was greater to produce evidence of an effort to change than to actually make the change in the teaching style. Clearly, an inflexable teacher will have trouble with anything needing change.

A second instructor with the same group of students was rather rigid, and used a number of structuring devices such as the black board, and outlines. The control showed a fairly flat line (see figure 1) and a corrolation of .59. When attempting to be structured this instructor was only able to more the regression line a very slight amount but in the direction of a flatter line. When asked to use an unstructured, student centered method, she feared she would be unable to do it and so invented case studies in which she could get the students more involved. The results were exactly opposite of that expected producing a nearly flat

Figure 1

GPA Scores and Post-Test Examination Scores for Fifty-Two Nursing Students with One Instructor Using Three Different Teaching Methods in Addition to Her Regular Style (control)

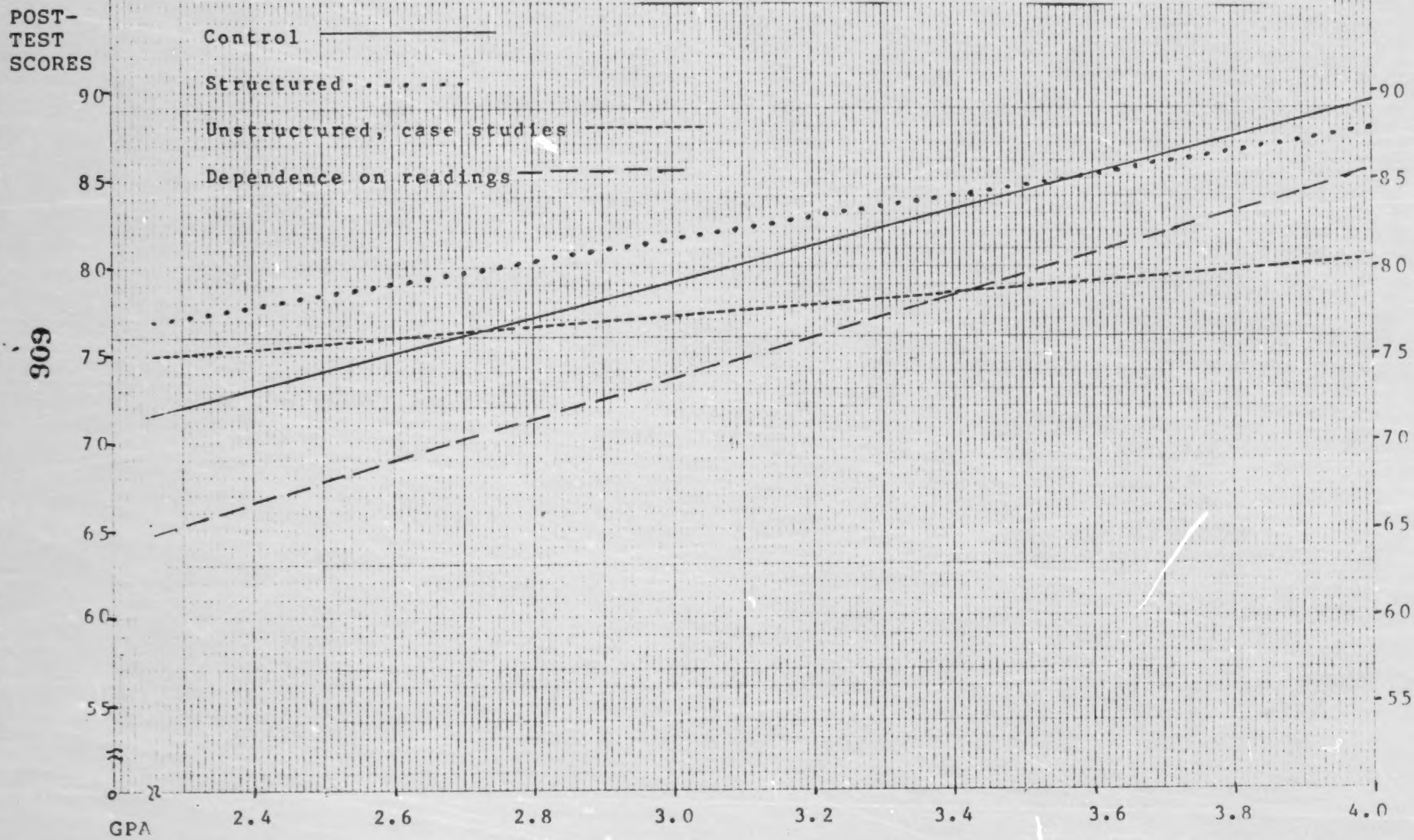

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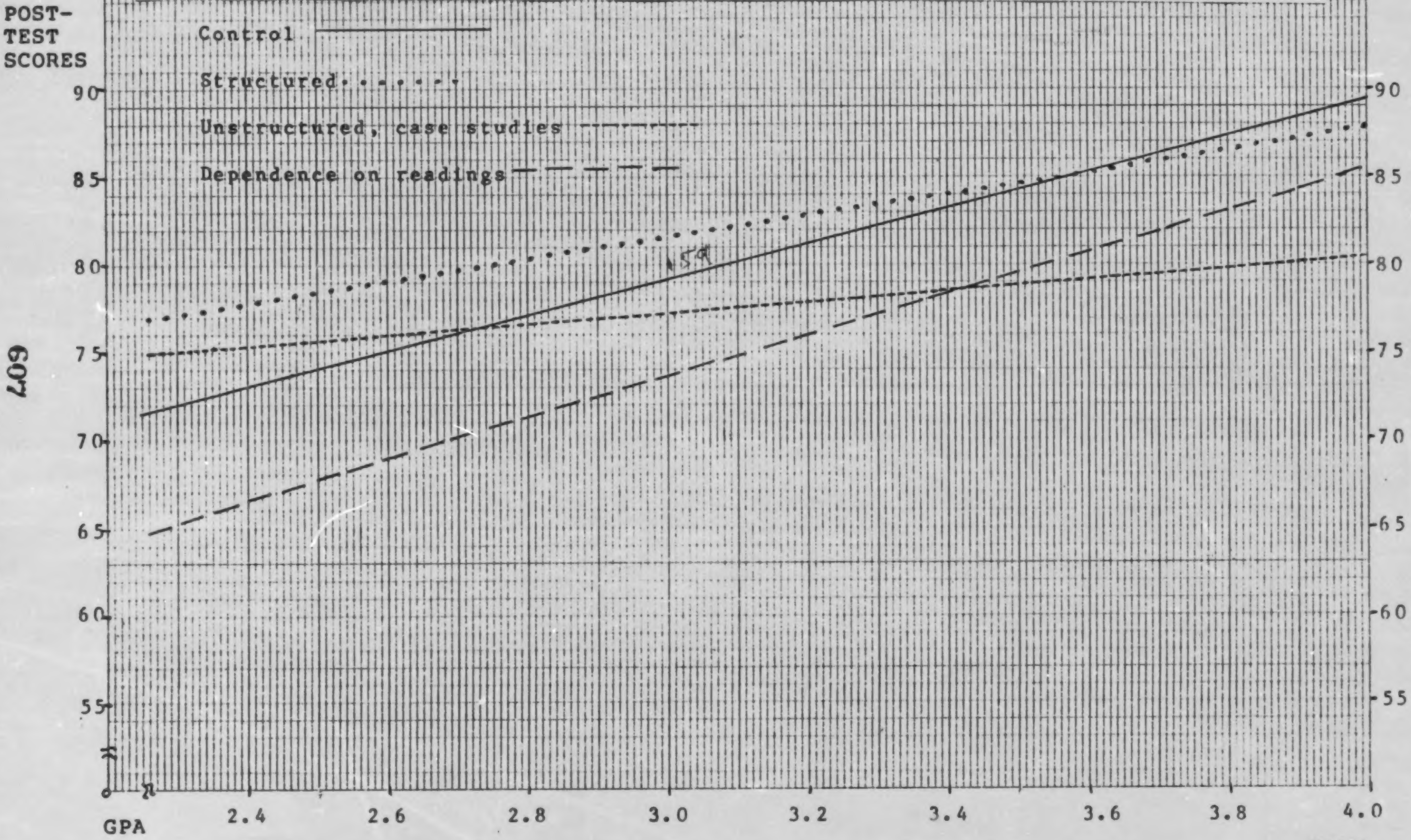
Figure 1

GPA Scores and Post-Test Examination Scores for Fifty-Two Nursing Students with One Instructor Using Three Different Teaching Methods in Addition to Her Regular Style (control)



line, lowering the grades of the higher students and raising the grades for the poorer students. In discussing the results the teacher guessed that the case studies chosen provided a memory cue for the poorer students and probably confused the better students who had completed the required reading for the course.

Later the same instructor produced test score for a block of learning material that depended a great deal on independent reading and completion of audio/visual learning packages. This included two hours of lecture that was covered in about thirty minutes, but was covered completely in the required readings. The total block represented about ten hours of classroom time. As the ATI literature indicated the slope of this line was quit steep compared to the previously submitted lines by this same instructor.

A third instructor who did not wish to make adjustments in her teaching style untill she had questions answered about the student's ability to adjust. She felt that between the first and second semester of her course the students adjusted to her style of the content and did better in general. Indeed the regression line indicate a fairly steep slope, and generally a low level of learning and in the second semester the slope remained about the same but the level of learning increased. The steeper slope could have been anticipated from the ATI literature as she seldom used the black board

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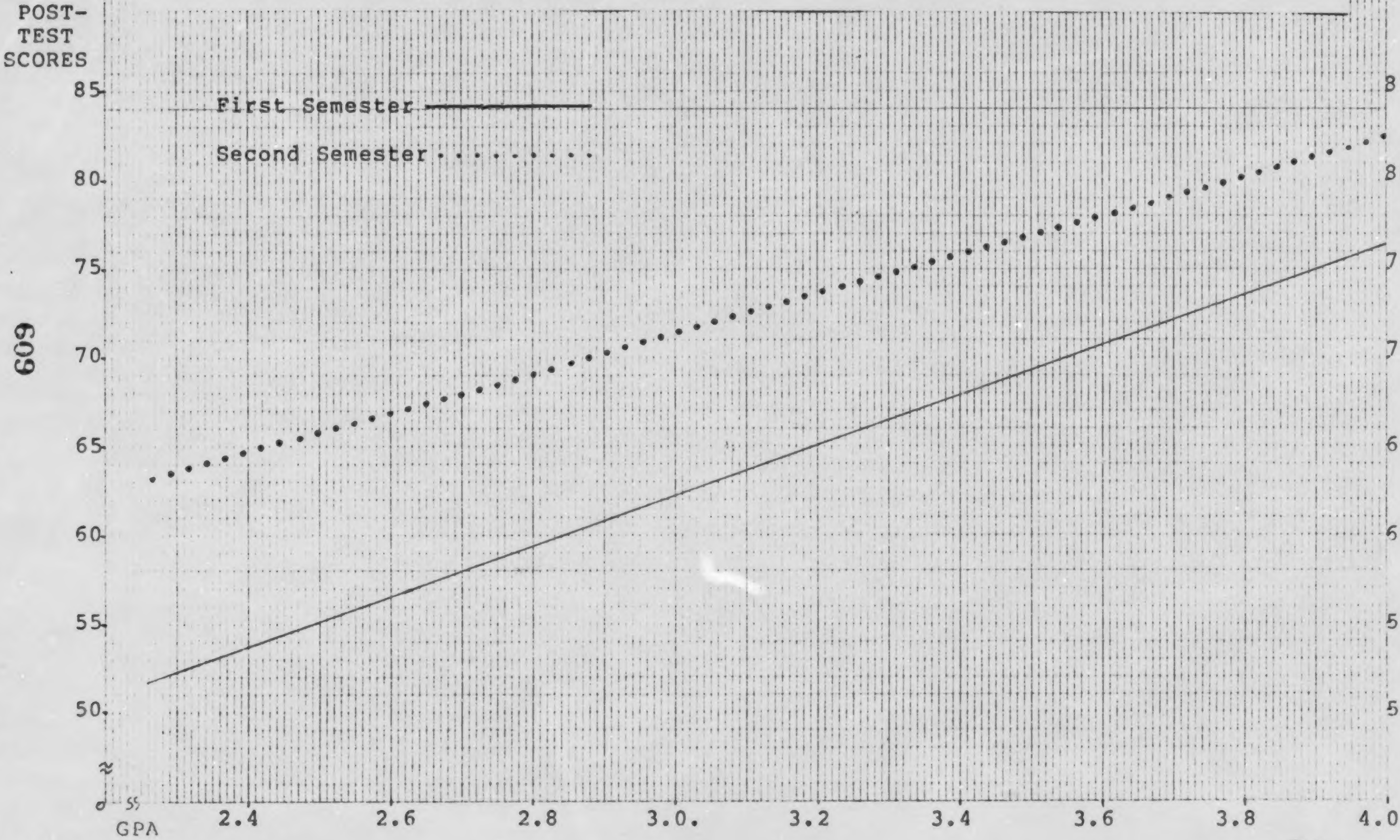
Figure 2

GPA Scores and Post-Test Examination Scores for Fifty-Two Nursing Students with One Instructor Showing the Difference from One Semester to Another



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640

and frequently tested on material from the reading. She also used application questions would would in itself seperate the better students form the poorer ones. (See figure 2).

Future Plans

It is hoped that the information obtained from this experiment will add a new dimension to the art and practice of teaching. Up to now teachers have had procedures and instruction about how they should plan and conduct a class. This model should add to that traditional body of material new knowledge about how students as a whold are responding to particular procedures. Teachers who are able to plan individually for students may not find this material useful. Teachers, however, who have fixed lectures and fixed hours with large numbers of students should at least be able to evaluate the effects of his own teaching methods.

Supervisors or faculty helping new teachers may also be able to use the information from both the scatter diagram and the slope of the regression line to quide beginners. The addition of this type of statistical evaluation would add a great deal to programs such as "The Teaching Improvement Process: The Clinic To Improve University Teaching" promoted by the Council for the Advancement of Small Colleges (Bergquist, 1977). Schools could base their teacher evaluation on such things as a higher correlation coefficient or a more desirable slope. It might be a shchool goal that grade distributions produce a regression line between 30 and 45 degrees from the horizontal. Where such goals are in use the combination of the statistical evidence and the guidance of the model (Table 1) might also help teachers meet the goal. When regression lines are used as an evaluation tool they have the advantage of objective reality as contrasted with verbal questionnaires, which are limited to subjective interpretation. The teacher does not need to be observed or orally evaluated by a senior faculty person.

A major unresolved issue concerns the moral and legal considerations briefly mentioned earlier and implied in the hypothetical situation proposed in the preceeding paragraph. At this time there is not enough information to do much more than speculate about what the future may hold. One possibility is that concerned parents and students might push for more individually prescribed instruction, leading to the allocation of funds for more teaching time and better testing services for individual students. There are others who speculate that home or cottage type learning will be replacing the public classroom, again to maximize the individual approach. Extended public debate may produce a socially accepted answer to the question of whether teaching should be directed primarily toward the brighter student, toward the slower learner, or toward neither. The present study merely explores the uses of a tool. It does not address the question of the purposes for which that tool should be put.

APPENDIX

Some basic concepts of ATI research

The problem studied in ATI research is whether treatments have differential effects on different subjects. This general problem can be given different specific formulations and be investigated with different methods, but one particular mode of attack has most frequently been employed.

In that approach one or more measurable characteristics are taken as one starting point. The individual differences variables can be of any kind: cognitive abilities, cognitive styles, personality constructs etc. It can be noted parenthetically that while researchers such as Cronbach and Snow (1969, 1975) refer to the individual differences variables as "aptitudes," others object to this on the grounds that this term has too narrow a connotation. Tobias (1969) prefers, for example, the term "attribute"; Berliner and Cahen (1973) the term "trait" (associated with the abbreviation TTI). Hunt (1975) has gone one step further and instead of the ATI paradigm has suggested the general B-P-E paradigm, which should be understand to mean that behavior is a function of person and environment. As another starting point two or more treatments are taken, the character of which cannot be specified in any more exact way than was the case for the aptitude variables. The relation between the aptitudes and outcome variables are then studied within each of the treatments.

Let us consider the simple case where there is only one aptitude variable (X) two treatments (A and B) and one outcome measure (Y). In figure 18, three hypothetical relations between the within-treatment regressions of the outcome measure on the aptitude variable are shown. In figure 18a the regression lines have an unequal slope in the two treatments so that they cross. A situation is thus depicted where pupils low in the ability have a better result with treatment A, while pupils high in the ability have a better result with treatment B. There is thus an interaction between the variable "aptitude" and the variable "treatment" in the prediction of the outcome. Following Lubin (1961) this type of interaction, where there are differences with different signs between the levels of one of the variables for different levels of the other variable, is labeled disordinal interaction.

In figure 18b there is also a difference in the slope of the regressions. The regression lines, however, fail to cross, which shows that treatment A gives a better result for all the levels on the aptitude variable, even though the difference in favor of treatment A is larger for higher scores on the aptitude variable. This type of interaction is termed ordinal interaction.

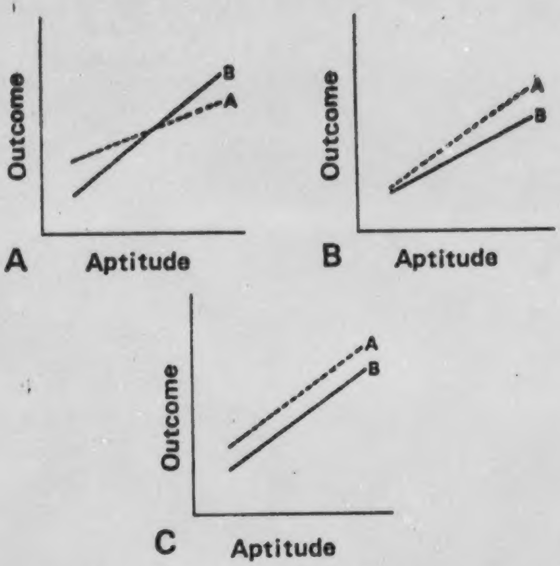


Figure 18 Three hypothetical outcomes in an ATI experiment.

n figure 18c the regression lines are parallel indicating no interaction etween aptitude and treatment.

Gustafsson, 1976

Used with the permission of Jan-Eric Gustafsson

Appendix B

Statistical Background

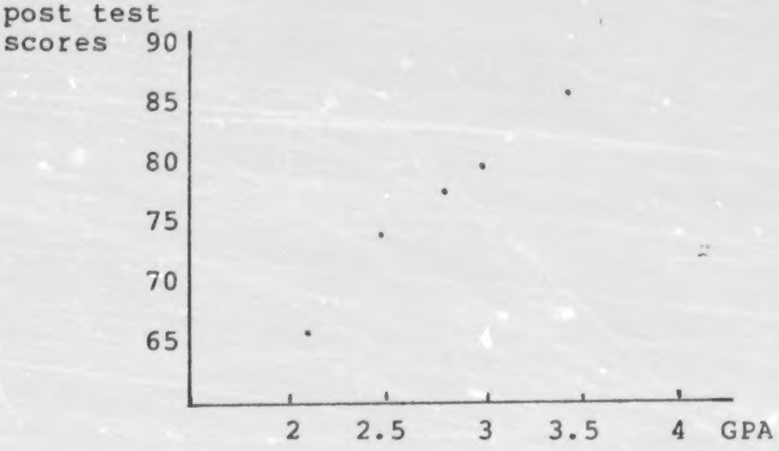
The model presented presently in chapter III is based on research that has been reported and reevaluated by McKeachie and Kulick (1975), Snow (1976), Cronbach and Snow (1981), as well as in more recent single studies. The summary in Table 1, alone with the more detailed description of its practical application, show how it can be used by teachers wishing to change the slope of a regression line to benefit the better students, poorer students, anxious students, etc. In this chapter I will provide a simple explanation of the statistical computation of the findings resulting from use of the model. The combination of the model , its explanation, and its statistical manipulation make a packet that should provide information for a teacher to do his own research and self evaluation.

Regression lines and correlation coefficients, (a measure of how closely change in one variable is related to change in a second) are formed using pairs of numbers. For example, a teacher with five students might want to correlate their GPAs with a post-test score.

To begin with, I will look at a five-student sample and show the steps necessary to arrive at the desired figures by using hand calculations. Later I will show how it can be done on a programmable calculator.

Sample:	GPA	Post-test
student 1	2.1	68
student 2	2.5	75
student 3	2.8	78
student 4	3.0	80
student 5	3.4	85

Let us say that GPA will be the X variable and we will plot it on the horizontal axis of a graph. Post-test scores will then be the Y variable, and they will go on the vertical axis.



Since this is an ideal example, it would be easy to estimate a regression line from this scatter, but let's go through the work for demonstration purposes.

Regression Analysis Using Formulas

To work the problem long hand we need to obtain several summary numbers before we can use the formula. We will need to find:

the number of pairs------------n
the sum of the X values--------ΣX
the sum of the Y values--------ΣX
the sum of X times Y-----------ΣXY
the sum of X squared-----------ΣX
the sum of Y squared-----------ΣY
the (sum of X) squared---------(ΣX)
the (sum of Y) squared--------(ΣY)

The number of cases = The number of pairs of scores in the study. $n = 5$

The sum of X = All the GPA scores for the students in the study added together. $\Sigma X = 13.8$

The sum of Y = All of the post-test scores for the students in the study added together. $\Sigma Y = 386$

The sum of X times Y = Each student's GPA multiplied by his post-test score. These numbers are then all added together.

2.1 times 68 = 142.8
2.5 times 75 = 187.5
2.8 times 78 = 218.4 $\Sigma XY = 1077.7$
3 times 80 = 240.0
3.4 times 85 = 289.0
1077.7

The sum of X squared = Each student's GPA is squared and then added together.

2.1 = 4.41
2.5 = 6.25
2.8 = 7.84 $\Sigma X = 39.06$
3.0 = 9.00
3.4 = 11.56
39.06

The sum of Y squared = Each student's post-test scores are squared and then added together.

68 = 4624
75 = 5625
78 = 6084 $\Sigma Y = 29{,}958$
80 = 6400
85 = 7225
29,958

The square of the sum of X = The sum of all the GPA scores (we already have this number) squared. $13.8 = (\Sigma X) = 190.44$

The square of the sum of Y = The sum of all the post-test scores squared. $386 = (\Sigma Y) = 148{,}996$

Now that we have all the needed numbers we are ready to look at the formulas and put in the numbers.

Correlation Coeficient.

This is a number ranging form "0" (which means that there is no relationship between the two variables) to "1" (which means that there is a perfect relationship between the variables). The formula for determining the coefficient is given below, followed by the computation for our sample problem.

$$r = \frac{\Sigma XY - \frac{(\Sigma X)\ (\Sigma Y)}{n}}{\sqrt{(X - \frac{(\Sigma X)}{n})\ (Y - \frac{(\Sigma Y)}{n})}} =$$

$$\frac{1077.7 - \frac{(13.8)(386)}{5}}{\sqrt{\left(39.06 - \frac{190.44}{5}\right)\left(29{,}958 - \frac{148{,}996}{5}\right)}} =$$

$$\frac{1077.7 - 1065.36}{\sqrt{(39.06 - 38.09)\ (29{,}958 - 29{,}799.2)}} =$$

$$r = \frac{12.34}{\sqrt{(.97)(158.8)}} = \frac{12.34}{\sqrt{154.04}} = \frac{12.34}{12.41} \quad .99$$

The correlation (r) in this sample is .99, very close to 1. This means that as the GPA increases, so do the test scores in almost perfect relationship, a much closer match than one would normally find in real life. For our purposes it tells us that the regression line (which we will calculate next) will fit all points on the scatter diagram almost precisely.

It is important to compute the correlation coefficient because if the correlation had been "0" or close to it (as it will be in one of the case studies) the regression line is not meaningful. Zero correlation would indicate that there is no relationship between the two sets of scores, as would be the case, for instance, if all students got a post-test score of 78 regardless of their GPA. Although a straight horizontal line would perfectly fit the data, it would indicate no relationship at all between the amount students learned and their intelligence. This would be most unusual since all of the literature indicates that there is some relationship between intelligence and learning, even when there is considerable disagreement on the measures used and on the strength of the relationship. It probably signifies a fluke: a problem with the method, the procedure, or the content that needs to be examined.

As noted, a correlation (r) of 0 shows no relationship between the variables; a correlation of 1 indicates a perfect relationship. The larger the value of r, the closer the relationship: an r value of .8 is closer than one of .6. In fact a precise idea of the closeness of fit is obtained from r^2 (Pearson product-coefficient), which reveals the relationship between the two variables in percentage terms. When $r=.8$, $r^2= .64$, which says that 64 percent of the changes in Y are associated with changes in X. The other 36 percent of the changes in Y are unrelated

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with (cannot be explained by) changes in X. An r^2 of .7 or less ($r = .49$ or less) tells us that less than half of the changes in Y can be explained in terms of changes in X.

Regression Line.

For drawing a regression line we need the same numbers used to calculate the correlation coeficient. From these we will derive two numbers, which can be translated into two points on the graph. Most descriptions of regression lines use the "intercept" value. This is the point where a line would cross the Y axis when the X value was "0". In our example (and in those used in the case studies) we can't use the intercept because the graph for neither the X nor the Y axis starts at "0". (No student has either an intelligence or a test score of zero.) For this reason the regression line we do produce should not be drawn so far as to actually touch the Y axis of the graph (zero intelligence). This is a minor point mathematically, but it has significant conceptual meaning in our present use.

To begin we need two formulae .

$$a = \frac{\Sigma Y}{n} - b\ \frac{\Sigma X}{n} \qquad\qquad b = \frac{n\ \ \Sigma XY - \Sigma XZY}{n\ \Sigma X - (\Sigma X)}$$

We will work the second one first.

$$b= \frac{(5)(1077.7)-(13.8)(386)}{(5)(39.06)-190.44} = \frac{5388.5 - 5326.8}{195.3 - 190.44} = \frac{61.7}{4.86}$$

$b= 12.695$

$$a=\frac{\Sigma Y}{n} - b\frac{\Sigma X}{n} = \frac{386}{5} - (12.695)\ \frac{13.8}{5} =$$

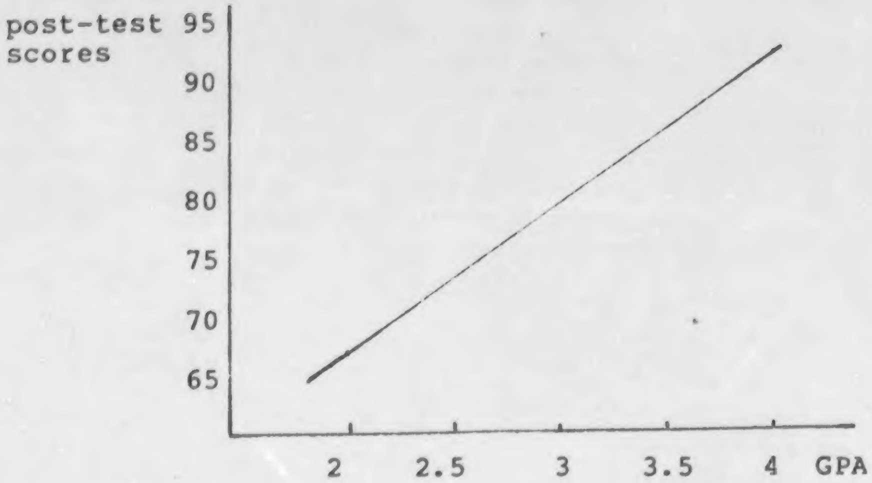
$$77.7 - (12.695)\ 2.76 = 77.2 - 35.038 = 42.162$$

In order to use these numbers on our graph we now need also to know common X and Y values. Since we can't use the intercept, we will pick any X value we wish within the range of normal GPA's and find a Y value for that X. By doing this twice, preferably at widely separated X values, we have two points from which we can draw a line. I will use GPAs of 4.0 and 2.0.

$$Y = a + b\ X = 42.162 + (12.695)\ 4 = 92.942$$

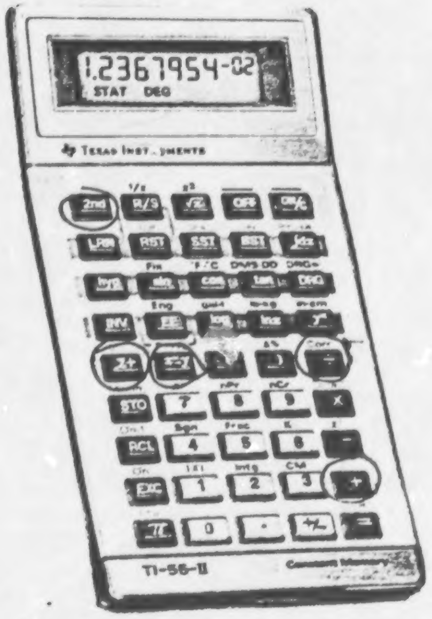
$$Y = a + b\ X = 42.162 + (12.695)\ 2 = 67.552$$

Now we can draw the line, which in this case is almost the same as the scatter, but is in any case a statistical average of the data. If one wished, one could predict post-test scores from it with a reasonable amount of accuracy (the more so the higher the correlation coefficient) by identifying the height at which a specific GPA touched the line on the vertical, post-test score, axis.



Now this is a lot of work, but there is a much simpler way to do it using a programmable calculator. An instruction book comes with the instrument but in case you borrow one, let me show you how to do it using a couple of different calculators:

Regression Statistics Using a TI-55-II (approximate cost $45).



Start by clearing the machine

press $\boxed{\text{on/c}}$ twice, $\boxed{\text{2nd}}$ $\overset{csr}{\boxed{=}}$

Now enter the pairs of numbers

	x value	y value
# 1	2.1	68
# 2	2.5	75
# 3	2.8	78
# 4	3.0	80
# 5	3.4	85

to enter numbers(be sure each number has registered before pressing $\boxed{\Sigma+}$ or $\boxed{X\rightleftharpoons Y}$).

Press 2.1 $\boxed{X\rightleftharpoons Y}$ 68 $\boxed{\Sigma+}$ (display= 1)
2.2 $\boxed{X\rightleftharpoons Y}$ 75 $\boxed{\Sigma+}$ (display= 2)
2.8 $\boxed{X\ Y}$ 78 $\boxed{\Sigma+}$ (display= 3)
3 $\boxed{X\rightleftharpoons Y}$ 80 $\boxed{\Sigma+}$ (display= 4)
3.4 $\boxed{X\rightleftharpoons Y}$ 85 $\boxed{\Sigma+}$ (display= 5)

You now have all of your data stored and the calculations are already done for you.

Correlation (r)= $\boxed{2nd}\ \overset{corr}{\boxed{\div}}$ (display) .99
Y=a+bX when X is 4 = 4 $\boxed{2nd}\ \overset{y^1}{\boxed{+}}$ (display) 92.94
Y=a+bX when X is 2 = 2 $\boxed{2nd}\ \overset{y^1}{\boxed{+}}$ (display) 67.55

You won't need to know a or b, but you can get them on the calculator to check your longhand work.

a= $\boxed{2nd}\ \overset{a/b}{\boxed{X}}$ = 42.16 b= $\boxed{2nd}\ \overset{a/b}{\boxed{X}}\ \boxed{X\rightleftharpoons Y}$ = 12.69

Regression Statistics Using HP-32E
(list price $65.00)

Hewlett-Packard makes a similar calculator with simple entry and calculation functions. Check the instruction manual for operational details.

HEWLETT PACKARD 32E

In order to use a large set of numbers for the real test to be sure that you know how to work the calculator and can produce the correct answer for the example given in this paper. For the real test use a real set of your own test scores and GPA's. Line up your pairs of numbers with student numbers or names so they are close together but easy to read. Enter each number carefully and slowly. It is possible to enter a number too quickly so that the calculator leaves off a digit, and you will never know that it has not been recorded correctly. If you make a mistake at some stage it can be changed but at others it is more difficult to repair (check the calculator manual). Given both the correlation coeficient and the regression line, you may choose not to draw the scatter diagram. For your first time, however, the diagram may give you a visual check on reality and help you interpret the numbers later on.

Student #	GPA	test-1	test-2

With this background you should be able to produce regression line statistics and, on an inexpensive piece of graph paper, translated those statistics into visual graphs of your class performance.

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TITLE: The Effectiveness of Student Achievement in Color and Black/White Cueing in Computer Assisted Instruction

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Abstract

The purpose of this experiment was to evaluate the effectiveness of color cueing in computer assisted instruction. Thirty kindergarten and first-grade students acted as subjects. They were randomly assigned to one of three treatment conditions: (A) received lecture instruction with black/white visuals, (B) received black/white cued computer assisted instruction, and (C) received color cued computer assisted instruction.

The materials consisted of a computer lesson on the basic shapes; circle, rectangle, and triangle. It was designed to cue the critical attributes of the shape and its name. The content was identical in all conditions with the exception of color. Before the subjects went through the instruction they were administered a pretest on recognition of the actual shape. Upon successful completion they progressed through the instruction on shapes found in natural objects. An immediate posttest was administered; 2 weeks later an identical test was administered to measure the delayed retention.

A one-way analysis of variance was conducted on the treatment conditions of the immediate and delay retention tests. A significant difference was indicated in the immediate retention analysis. A retentional analysis was conducted to indicate the treatment condition's effect on informational loss. Scheffe's multiple comparison method was used to compare the treatment conditions in the different shape responses. No consistent results were established leading to the conclussion that the use of color cueing in computer assisted instruction is an effective instructional variable in delayed retention but not as effective as black/white cueing in immediate learning situations.

The Effectiveness of Student Achievement In Color and Black/White Cueing In Computer Assisted Instruction

Color has been used in instructional illustrations for several years. It has been used to inhance the education of preschoolers to adults. For this reason, the manner in which color is employed in instructional illustrations is important. The improper use of color can increase the complexity of information to the student. However, when color is used judiciously it can be instructionally effective and aesthetically pleasing.

Teachers are confronted with a wide variety of instructional materials for the classroom. Each day they face the problem of selecting and organizing visualized materials for the most effective inducement of student achievement. To alleviate this problem, there is a need for critical assessment of the available visualized materials. Lamberski (1975, p. 1) summarized the problem as follows:

> In view of the widespread use of currently available materials it would be educationally desirable to have materials tested and improved as much as possible. To do this requires a complete knowledge of what elements contribute to effective instructional materials.

It is known that learners process information in different ways. Color can be used as an aid in that coding of visualized instruction. Dwyer (1971, p. 7) discusses color as a coding mechanism:

> Although color is an important variable in the design and cost of instructional materials, the research concerning its effectiveness in increasing student learning is at best inconclusive . . . . There is very little experimental evidence available as to how the addition of color to various types of visual, illustrations will affect student achievement . . . . It appears that guidelenes for the uses of color should be established as quickly as possible.

In surveying the color literature, researchers (Green & Anderson, 1956; Smith, 1963; 1964; 1965; Chan, 1965; Black, 1967; Dwyer, 1967; 1968; Lamberski, 1975; 1979) found color to be a viable instructional variable for increasing student achievement. Results indicate that the use of visual materials to complement oral/print instruction yields varied effects in different instructional environments. The effectiveness is dependent upon (a) the amount of realistic detail used in the visual; (b) the method to present the visualized instruction; (c) learner characteristics; (d) the type of educational objective desired; (e) the attention focusing technique; and (f) the type of test format used.

The purpose of this study was to measure the effectiveness of color and black/white cueing to induce student achievement in computer assisted instruction. This particular aspect of color research was chosen based on the previous studies. Much of this research leads to conflicting evidence on the use of color. In the majority of these studies, the subjects used were college students and adults. If teachers are to make judgements on the use of visualized instruction in the classroom they need to have information based on the younger subjects with whom they are working. For this reason, the subjects chosen for this study were kindergarten and first-grade students. At this age level, teachers must rely on a vast amount of visualized materials due to the reading level of this age group.

Another variable in this study was the method of presentation. Several of the studies previously done used slides, film, or programed booklets. For this reason, the material was presented via computer assisted instruction. With the new technology providing computers in the classrooms, research needs to be conducted as to its effectiveness in student achievement. It is generally assumed that computer instruction is effective in increasing motivation and retaining student attention. The use of color as opposed to black/white presentation is an area in which little research has been conducted.

This study was designed to bring information to these areas. The research will refer to the educational implications of color and its use with younger students in computer assisted instruction.

Research Study

Statement of Problem

The use of visual materials to complement oral and printed instruction is becoming an established procedure in conventional instruction (Dwyer, 1971). Previous research has indicated that students prefer to view colored instructional material rather than black/white (Long, 1945; Malter, 1948).

The purpose of this study was: (a) to measure the effectiveness of two types of cueing, color and black/white, found in simple line drawings on immediate and delayed retention tests, (b) to determine whether the two types of cueing are equally effective in facilitating student achievement, (c) to determine the retentional value of the two types of cueing.

In this study the independent variables are the types of cueing, color or black/white and the means of presentation, lecture or computer assisted instruction. The dependent variable is the recognition of shapes in natural objects which is measured by the posttests.

Throughout the study an effort was made to insure that the visualized materials were identical in terms of content for all treatments. The preparation and design of materials include three complete sets of visual materials for presentation and evaluation.

Based on previous research, it is predicted that the use of computer assisted instruction will facilitate student achievement to a greater degree than the lecture instruction. It is also predicted that the use of color cueing will be no less effective than the black/white on immediate and delayed retention tests.

Method

Subjects. Thirty kindergarten and first-grade students, ranging in age from 5 to 7 were used as subjects. The subjects were all students at a public elementary school in Minnesota. They were randomly selected with equal numbers from each of the high, average, and low ability reading groups. These groups were again randomly distributed to the three treatments. Ten students participated in each treatment group.

Design. The materials for the study were made of three individual components, one for each treatment. The content material in each was identical. Materials for the lecture group consisted of a series of 8½ X 11 black on white simple line illustrations: (a) definition cards for each shape: circle, rectangle, triangle, along with an illustration of each, (b) illustration cards for each shape in a natural object. The pretest and posttest were an 8½ X 11 black on white paper test. All verbal dialog to the subjects of the lecture group was read from a preprepared script.

The materials for the two computer assisted instruction groups were prepared on the Apple II Plus microcomputer using the Higher Text Authoring Package by Synergistic, Inc.. All programming was done by the author in the BASIC language. The programs were identical in content with on treatment having black/white and the other color cueing. The program with color cueing used color to emphasize the shape name and the critical attributes of the shapes for the definition and practice examples. Color was used as feedback outlining the correct shape. Whereas the subjects were nonreaders, the written information was read to them verbatim by the examiner.

The delayed retention test was a 8½ X 11 black on white paper test. It contained the identical content as the immediate posttest.

All statistical tests were conducted at the .05 level. Upon completion of instructional presentation, the subjects were administered an immediate retention test. Analysis of the immediate retention test was conducted by a one-way analysis of variance.

Two weeks after the immediate retention test, subjects were called back for a delayed retention test. This test was identical in content to the immediate retention test. Analysis of the delayed retention test was conducted by a one-way analysis of variance on the test scores. Multiple comparisons between treatment means were analyzed by the Scheffe multiple comparison method.

A retention analysis, which was computed by subtracting the delayed test scores from the immediate test scores, was conducted the same way as the delayed analysis.

Treatment. Subjects were randomly assigned to one of three treatment groups. Two of these treatments were a computer assisted instructional program and the third served as a control lecture.

Treatment (A). Subjects in treatment (A) received lecture instruction along with black/white simple line visuals. A pretest of shapes consisted of a paper-pencil test. Upon successful completion, subjects as a group were presented practice items of shapes in natural objects. A paper-pencil immediate posttest followed the instruction.

Treatment (B). Subjects in treatment (B) received black/white computer assisted instruction. A pretest and posttest was included in the program.

Treatment (C). Subjects in treatment (C) received color cued computer assisted instruction. Correlating colors which indicated the shape name to the critical attribute of the shape are as follows: circle- green, rectangle- red-orange, and triangle- blue. A pretest and posttest was included in the program.

Procedure. Each subject participated in only one treatment. Those subjects in treatment (A) were verbally given the definition of each shape complimented by a visual example of each. Subjects were then given a pretest on the basic shapes to ensure comprehension of these shapes. Upon completion, the subjects as a group were exposed to a series of visuals of shapes in natural objects. They orally stated which shape was seen in the illustration. After the presentation they were given a paper-pencil posttest to indicate the recognition of shapes in natural objects.

The subjects in treatment (B) and treatment (C) individually went through a computer assisted instruction program on the Apple II Plus microcomputer. The program defined the shapes and showed examples of each. The subjects then took a shape recognition posttest consisting of four items of each shape. Upon completion they were exposed to 21 practice items of shapes in natural objects. Feedback was given in the manner of right/wrong response and in treatment (C) correlating color was added to define the shape in the illustration. Following the practice items, a posttest was given. Subjects were allowed as much time as they needed to proceed through the programed instruction.

Whereas the subjects were nonreaders, written information was read verbatim by the examiner.

After a two week period, subjects from all treatment groups were called back for a delayed retention test. The test was a black/white paper-pencil test identical to that of the immediate posttest.

Results

Immediate Analysis. The means and standard deviations for the posttest data are shown in Table 1. An analysis was done for each shape tested as well as the different treatment conditions. A one-way analysis of variance was used to test the effects among the three treatment conditions. The results of this can be seen in Table 2. As can be seen, the test of significance ($F=6.836$, $df=2/27$, $p<.01$) proved to be highly significant. The means of treatment presentation significantly affected the learning.

Delayed Analysis. The means and standard deviations for the posttest data are shown in Table 3. An analysis of variance conducted on the posttest scores indicated that no significant differences ($F=0.2895$, $df=2/27$, $p>.05$) existed in the treatment conditions for delayed retention (see Table 4).

Retentional Analysis. An analysis of variance on the informational loss scores, derived by subtracting the delayed retention test scores from the immediate retention test scores, indicated that a significant difference ($F=10.49$, $df=2/27$, $p<.01$) existed among the treatment conditions (see Table 5). Table 6 shows the statistical analysis for the retentional analysis. Significant differences were found in the rectangle responses (F=15.894, df=2/27, p<.01), the triangle responses (F=20.031, df=2/27, p<.01), and the total response (F=10.49, df=2/27, p<.01). In the summary of the means, a negative mean indicates the retentional value improved from the immediate retention test to the delay retention test, thus there was no informational loss. This occurred in both the lecture and color CAI presentations.

A summary of the treatment comparisons for the retentional value was conducted via the Scheffe multiple comparison method. The results are shown in Table 7. In the comparisons the lecture presentation was found to increase retention significantly as opposed to black/white CAI presentation in the circle and total responses and as opposed to color CAI in the rectangle responses. Color CAI was found to be less receptive to informational loss than black/white CAI in the rectangle responses.

Disscussion and Conclusions

The data collected in this study appears to support the contention that the addition of color in computer assisted instruction does not mean a significant increase in student achievement. There appears to be other related factors.

When analyzing the results of the study we find that in most cases the treatment presentation did make a significant difference in student achievement. In the learning process, measured by the immediate retention test, the computer assisted instruction improved achievement significantly over the lecture presentation. This supports the initial hypothesis that the student achievement would be greater in the computer assisted instruction than the lecture presentation. Furthermore, the second hypothesis was also supported for the students in the color CAI achieved the greatest retention of information. These results would correspond to the findings of Smith (1963), Smith and Thomas (1964), and Smith, et al. (1965).

The results of the delayed retention test did not prove significant. All treatments attained approximately the same results. This may have been due to the use of a paper-pencil test for all treatments as opposed to computer assisted instruction.

The retentional analysis again proved to be significant among treatments. This analysis looked at the amount of informational loss after two weeks. When analyzing the treatments by their respective shape, the rectangle, triangle, and total proved to be significant. In the rectangle the color CAI treatment had no informational loss and actually improved on the immediate retention score. This also appears in the triangle analysis. The lecture presentation for these shapes showed the highest informational loss. In the total scores, however, the lecture proved to retain information significantly better than the computer assisted instruction. In all cases, the color CAI proved significantly to improve retention over the black/white CAI. This would support the hypothesis that color cued computer assisted instruction would improve student achievement to a greater degree than black/white computer assisted instruction.

Like the previous research on color, the study proved to have inconclusive results. The hypotheses were supported though not in a significant amount of the data. The study did reveal that different coding techniques do elicit varying levels of student achievement. The results would indicate that care must be taken when designing instruction for specific results. Each presentation proved to be successful for varying levels of retention; immediate retention- black/white CAI, delayed retention- color CAI, and information retention- lecture presention. Perhaps instruction could be designed around the retentional outcome desired. An example of this would be tasks that must be learned for immediate use could be presented with black/white CAI as opposed to tasks where retention of information is important would be of a lecture presentation. It would be necessary for additional research in this area before conclusions can be made.

There appears to be a need for additional research in color coding of computer assisted instruction. Seperate coding techniques by multifactor designs to investigate the relationship and interaction of presentation evaluation, pacing, educational tasks, individual learner characteristics, and consistency of testing and presentation modes.

In summary, this study was to evaluate the effectiveness of color cueing in computer assisted instruction. Thirty kindergarten and first-grade students acted as subjects. They were randomly assigned to one of three treatment conditions: (A) received lecture instruction with black/white visuals, (B) received black/white cued computer assisted instruction, and (C) received color cued computer assisted instruction.

The materials consisted of a computer lesson on the basic shapes:

circle, rectangle, and triangle. It was designed to cue the critical attributes of the shape and its name. The content was identical in all conditions with the exception of color. Before the subjects went through the instruction they were administered a pretest on recognition of the actual shape. Upon successful completion they progressed through the instruction on shapes found in natural objects. An immediate posttest was administered; two weeks later an identical test was administered to measure the delayed retention.

A one-way analysis of variance was conducted on the treatment conditions of the immediate and delay retention tests. A significant difference was indicated in the immediate retention analysis. A retentional analysis was conducted to indicate the treatment condition's effect on informational loss. Scheffe's multiple comparison method was used to compare the treatment conditions in the different shape responses. The results led to the conclusion that the addition of color in computer assisted instruction does not mean an efficient increase in student achievement. Additional research in this area is needed to investigate color as opposed to black/white computer assisted instruction.

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Table 1

Treatment Summary for the Immediate Retention Analysis

	(A) Lecture Presentation		(B) Color CAI		(C) B/W CAI	
	M	*SD*	*M*	*SD*	*M*	*SD*
Circle	3.6	.4899	5.3	.7483	5.7	.6403
Rectangle	3.7	.4583	4.1	1.1358	4.6	.6633
Triangle	4.2	.9055	4.2	.9798	4.9	1.044
Total	11.6	1.2806	13.6	2.6153	15.2	2.0881

Note. Maximum score for each shape = 6.

Maximum score for total = 18.

Table 2

Analysis of Variance for the Immediate Retention Analysis

Source of Variation	*SS*	*df*	Variance Estimate
Between	65.07	2	$32.54 = s_b^2$
Within	128.4	27	$4.76 = s_w^2$
Total	193.47	29	$F = 6.836^{**}$

$^{*}p<.05$. $^{**}p<.01$

Table 3

Treatment Summary Table for the Delayed Retention Analysis

	(A) Lecture Presentation		(B) Color CAI		(C) B/W CAI	
	M	SD	M	SD	M	SD
Circle	4.0	.1414	4.4	.8	4.5	.8062
Rectangle	4.8	.4	4.5	.922	3.8	.4
Triangle	4.5	1.0247	4.6	1.1136	4.6	1.0198
Total	13.3	1.5524	13.5	2.1095	12.9	1.1358

Note. Maximum score for each shape - 6.

Maximum score for total = 18.

Table 4

Analysis of Variance for the Delayed Retention Analysis

Source of Variation	SS	df	Variance Estimate
Between	2.6	2	$1.3 = s_b^2$
Within	121.2	27	$4.489 = s_w^2$
Total	123.8	29	$F = 0.2895$

$^*p < .05$. $^{**}p < .01$.

Table 5

Analysis of Variance for the Retentional Analysis

Source of Variation	SS	df	Variance Estimate
Between	77.0	2	38.5 = s_b^2
Within	99.1	27	3.67 = s_w^2
Total	176.1	29	F = 10.49**

*$p < .05$. **$p < .01$.

Table 6

Summary of the Statistical Analysis of the Different Shapes for the Retentional Analysis

I. Circle F-Ratio (df = 2/27) = 3.10

Treatment	M	SD
Lecture (A)	-0.4	0.3795
Color CAI (B)	0.9	0.6708
B/W CAI (C)	1.2	0.7267

II. Rectangle F-Ratio (df = 2/27) = 15.894**

Treatment	M	SD
A	1.1	0.3606
B	-0.4	0.955
C	0.8	0.4196

III. Triangle F-Ratio (df = 2/27) = 20.031**

Treatment	M	SD
A	0.2	0.7616
B	-0.4	0.687
C	0.3	0.795

IV. Total F-Ratio (df = 2/27) = 10.49**

Treatment	M	SD
A	0.9	0.567
B	0.1	2.0025
C	2.3	1.4967

*$p < .05$. **$p <$ 01.

Note. A negative mean indicates the retention improved in the delay scores.

Table 7

Summary of the Treatment Comparison

	Comparison	F-Ratio
I. Circle		
Treatment	Lecture (A), Color CAI (B)	10.92
	Lecture (A), B/W CAI (C)	16.54**
	Color CAI (B), B/W CAI (C)	0.58
II. Rectangle		
Treatment	A , B	32.45**
	A , C	5.96
	B , C	95.36**
III. Triangle		
Treatment	A , B	0.94
	A , C	0.65
	B , C	1.27
IV. Total		
Treatment	A , B	4.41
	A , C	21.79**
	B , C	6.59

*$p<.05$. **$p<.01$.

TITLE: Effects of Presentation Mode on Student Attitude Towards Non-Traditional Careers

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Effects of Presentation Mode on Student Attitude Towards Non-Traditional Careers

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Introduction

Recently educational researchers have emphasized the importance of fostering productive attitudes within the framework of education, particularly through the use of positive role models (Kahn & Weiss, 1973). Gagné (1977) and Fleming and Levie (1978), hold that attitudes are most effectively changed via the use of human modeling of desired behavior, based on the social learning theory of Bandura (1977). The effects of role modeling on attitude change have been demonstrated with regard to both racial prejudice and gender. Kraus (1962) found that white high school students' attitudes toward blacks became more positive after viewing role models who were credible and similar to the students. Plost and Rosen (1974) found that eighth graders demonstrated a preference for occupations depicted by models of the same sex as themselves. Lockheed and Harris (Note 1) found that fourth and fifth graders who had experienced men and women working in roles not traditional for their sex within the school environment held less sex-stereotyped attitudes towards the roles of men and women in society than children who had not experienced these role models.

The forms in which human role models have been presented to students in educational research has varied. Gagné (1977) holds that the model need not appear in person. One of Bandura's early studies investigating learning which occurred through observation of a model's behavior demonstrated that preschool children imitated aggressive behavior that they had observed in a film (Bandura,1963). Schau (Note 2) found that presenting elementary school children with a series of appealing stories about men and women who worked in jobs not traditional for their sex produced in students a significantly less stereotyped attitude towards the appropriateness of the jobs for both men and women. Written descriptions of males and females who work in careers that are traditionally associated with the opposite sex were presented to ninth graders by Greene, Sullivan, and Beyard-Tyler (1982). Students who read the descriptions of the models showed significant attitude change, rating more traditionally sex-stereotyped careers as being appropriate for both sexes.

Non-print presentations of information have not been widely used in educational research to affect attitude. Cohen, Ebeling, and Kulik (1981) found that only 16 of 74 visual-based studies they reviewed reported data on student attitude. In none of these was attitude the primary criterion variable. Further, Simonson, Thies, and Burch (1979) found that most of the 42 studies they reviewed measured attitude toward the medium or subject matter rather than toward issues. Since presentation of role models is an important factor in affecting attitude and attitudes can be changed via the print medium, a greater change may result from using media which more realistically depict the role models.

Another factor that appears to affect attitudes, particularly with regard to sex-stereotyping, is the sex of the student. Plost and Rosen (1974) confirmed that female junior high school students expressed preferences for occupations depicted by like-sex models significantly more frequently than males. Schau (Note 2) found some sex differences, and when these existed males were more sex-stereotyped in their responses than females. Greene et al. (1982) reported that, following instruction, more female students rated jobs as being appropriate for both men and women than did male students.

The purpose of the present study was to compare attitude change when role models are described in print with when they are shown in a slide/tape presentation. Three levels of presentation mode (slide/tape, print, control) were crossed with two levels of sex of student (male, female). Student attitudes toward jobs were measured using an Occupation Survey adapted from Greene et al. (1982). It was expected that visual representation in slide/tape form of a person in a nonstereotyped occupational role would have a greater effect on attitude than would reading about a person in such a role.

Method

Subjects

Subjects were 188 ninth grade students, 97 males and 91 females, enrolled in required science classes at a suburban junior high school in the Phoenix metropolitan area.

Materials

The experimental materials consisted of two presentations of identical career information adapted from Greene, Sullivan,and Beyard-Tyler (1982). A brief passage introduced career opportunities now available to men and women. Four career descriptions, two male--civil engineer and computer service technician--and two female--nurse and librarian--were then presented in one of two forms, either in print or in a slide/tape. The careers chosen met a standard set of criteria. All were projected by the Bureau of Labor Statistics (1978) to have good growth potential for the 1980's. At least 80% males are employed in the male jobs. At least 80% females are employed in the female jobs.

The career descriptions had been prepared from information obtained in interviews with men and women working in careers not traditionally associated with their sex. The individuals in the descriptions presented reasons for their job choices, characteristics of their jobs, and training required for their jobs. The descriptions averaged 300 words in length and had readability scores ranging from 6.7 to 7.8 as determined by the Dale-Chall Readability Formula (Dale & Chall, 1948).

Both career presentations included the introductory passage in print form. The career descriptions were prepared in two forms: a printed booklet and a seven minute slide/tape presentation. The narration for the slide/tape was identical to the written career descriptions. Each description was read by a person of the same sex as the individual described. The visuals consisted of ten 35mm slides of each individual performing job tasks in his or her work environment.

Procedures

Students were randomly assigned by sex to the slide/tape treatment group, print treatment group, or control group. Trained experimenters conducted the study during regularly scheduled classes.

Treatments for the three groups consisted of the following sequences:

(a) Slide/tape group. Students read the introductory passage, viewed the slide/tape presentation of the career descriptions, and completed the Occupation Survey.

(b) Print group. Students read the introductory passage, read the career descriptions, and completed the Occupation Survey.

(c) Control group. Students completed the Occupation Survey only; they received no information.

Criterion Measure

The Occupation Survey was designed to measure student attitudes about the appropriateness of certain sex-typed jobs for both men and women. The survey consisted of items related to attitudes about sex-typed jobs, four which were presented in the treatments and two, bank manager and flight attendant, which were not presented. The order of job titles was rotated to avoid an order effect.

Students responded to three items for each job. In the first item students rated each job according to their perceptions of the job's appropriateness for men or women. A five point rating scale elicited student responses about whether each job was appropriate for only men, only women, more men than women, more women than men, or both men and women. Based on their responses, students received a rating of degree of sex-stereotyping. A response of "only men" or "only women" received a rating of 0. A response of "more men than women" or "more women than men" received a rating of 1. A response of "both men and women" received a rating of 2. Mean ratings for each student thus ranged from 0 to 2, or "most sex-stereotyped" to "least sex-stereotyped".

The second and third items assessed whether students felt each job was high, medium, or low status, and the degree to which they would enjoy doing the job. These items were included to avoid oversensitizing students to the sex appropriateness item. Responses to these items were not analyzed.

Design and Data Analysis

A 3 (presentation mode) x 2 (sex of subject) factorial design was employed. Data were analyzed using the mean sex-stereotype rating for each student.

Two separate analyses of variance were performed, one comparing ratings of males and females by treatment groups on the jobs presented, and the other comparing ratings on the jobs not presented.

Table 1.

Mean Ratings by Sex of Subject
by Presented/Not Presented by Presentation Mode

Sex of Subject	Presented/ Not Presented	Presentation Mode: Media	Presentation Mode: Print	Presentation Mode: Control	Total
Male	Presented	1.36	1.35	1.05	1.26
	Not Presented	1.41	1.31	1.21	1.31
Female	Presented	1.61	1.50	1.36	1.48
	Not Presented	1.80	1.42	1.64	1.61
Total	Presented	1.47	1.42	1.22	1.37
	Not Presented	1.58	1.36	1.43	1.46

9% - 10%

N=188
Main effects on four jobs presented for sex of subject, $F(1,187)=13.03$, $p<.0001$, and presentation mode, $F(2,187)=6.31$, $p<.002$.
Main effects on two jobs not presented for sex of subject, $F(1,187)=15.75$, $p<.0001$, and presentation mode, $F(2,187)=3.12$, $p<.05$.

Results

The mean sex-stereotype ratings on the Occupation Survey are shown in Table 1. Ratings ranged from 0, or most sex-stereotyped, to 2, or least sex-stereotyped. Significant effects were obtained for presentation mode on both jobs presented, F(2,187) = 6.31, $p<.002$, and on jobs not presented, F(2,187) = 3.12, $p<.05$. A significant effect was also obtained for sex of subject on both jobs presented, F(1,187) = 13.03, $p<.0001$, and on jobs not presented, F(1,187) = 15.75, $p<.0001$.

For jobs presented the overall mean rating was 1.37. Differences for presentation mode were obtained. The mean ratings were 1.47 for the slide/tape group, 1.42 for the print group, and 1.22 for the control group. The Student-Newman-Keuls multiple range test at the .05 level revealed that both the slide/tape and the print treatment groups yielded significantly less sex-stereotyped ratings than the control group.

For jobs not presented the overall mean rating was 1.46. The mean ratings by presentation mode were 1.58 for the slide/tape group, 1.36 for the print group, and 1.43 for the control group. The significant effect for presentation mode on jobs not presented reflects the higher rating under the slide/tape condition than under the print and control conditions.

Mean ratings for female students indicated less sex-stereotyping than males. The mean rating on jobs presented was 1.48 for females and 1.26 for males. The mean rating on jobs not presented was 1.61 for females and 1.31 for males.

Discussion

In this study students were presented with information about men and women working in careers not traditional for their sex in one of two

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presentation modes, slide/tape or print. It was anticipated that students who viewed or read descriptions of non-traditional role models would rate more jobs as being appropriate for both men and women than students who did not receive the role model information. It was further anticipated that viewing the slide/tape would be more effective in producing an attitude change than reading the information in print form.

The results showed an attitude change partially consistent with the change anticipated. On jobs presented, both the slide/tape and print treatments yielded higher ratings than the control treatment, but the ratings of the two groups did not differ significantly from each other. Thus on jobs presented the slide/tape version did not yield the higher, more positive attitudes that had been expected.

On jobs not presented there appeared to be a pattern which indicated a more powerful effect for the slide/tape presentation. The print and control group ratings were similar, with the control group rating being slightly higher; the slide/tape group rating was higher than either. This suggests the possibility that the effects obtained with a pictorial, and thus more realistic, presentation may generalize to similar content more than those obtained with a print presentation.

This greater apparent effect for pictorial presentation than for print presentation deserves further consideration. Evidence of the investigation of the generalizing effect of print media is as yet inconclusive. Schau (Note 2) found no generalizing effect on attitude towards jobs not presented when presentation was in print form. Greene et al. (1982) found, however, a significant generalizing effect with print on attitude towards jobs not presented. Since the generalizing effect in this study was significant but not highly so, and since attitude ratings for jobs not presented were based on only two jobs, rather than a wide variety of jobs, further investigation would be needed to confirm this effect.

Strong differences based on sex of subject were found. Female students had higher mean ratings than male students overall, under each of the three presentation modes, and whether the jobs on which their attitudes were measured had been presented or not. This indicates that girls hold less sex-stereotyped attitudes than boys, rating more jobs as being appropriate for both men and women. This difference in sex-stereotyping of attitudes is consistent with the findings of Plost and Rosen (1974) and Greene, Sullivan, and Beyard-Tyler (1982). It appears that girls do believe that men and women can both perform more jobs than boys do.

The effectiveness of the use of positive role models to affect student attitude, as described by Bandura (1977), Fleming and Levie (1978), and Gagné (1977), is supported by the results of this study. It appears that print and slide/tape presentations are about equally effective in affecting student attitudes towards content, but that these attitudes may generalize more strongly towards content not presented when presentation is in slide/tape form. This interpretation is still open to question because attitudes were measured towards only two jobs not presented in the experimental materials. Further research should help indicate the degree to which media presentations of information influence the generalization of attitudes towards similar unpresented content.

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TITLE: The Application of Naturalistic Inquiry
to Program Evaluation

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The Application of Naturalistic Inquiry to Program Evaluation

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The past few years have seen the introduction and development of an iconoclastic movement within the evaluation field. Most changes within academic disciplines do not warrant the term iconoclastic. However, this author uses the adjective intentionally here. For if the word is saved for that which challenges cherished beliefs and institutions, naturalistic inquiry is iconoclastic. It presents an alternative set of assumptions and consequent methodologies that challenge the established beliefs of the research and evaluation community.

Through the brief case study described in this paper the author seeks to illustrate the application of naturalistic inquiry to program evaluation. The goal here is to look at naturalistic assumptions and methodologies operating in 'real world' actions and to examine their results. First, the distinction will be made between the assumptions underlying naturalistic inquiry and those behind experimentalism and preordinate (Stake, 1975) evaluation. A brief summary of the consequent methodologies preferred by naturalists follows; these will be described in contrast to current practices stemming from classical experimental design. An actual evaluation that proceeded from naturalistic assumptions and illustrates some of the data gathering and analysis techniques associated with naturalistic inquiry will then be described. Some of the major results of the evaluation will be presented as a means of characterizing the kinds of results yielded by naturalistic evaluation. Finally, some of the difficulties encountered in naturalistic evaluation will be discussed.

Assumptions

The following discussion of assumptions draws heavily on the work of

Egon Guba (1981) in which he distinguishes between the naturalistic and rationalistic paradigms. Rationalistic is the term chosen by Guba (1981) to describe the paradigm that dominates inquiry and evaluation today; it refers to classical experimentalism or approximations thereof. According to Guba (1981), the assumptions behind these two paradigms differ along three dimensions. The presentation of these dimensions here will be brief since thorough discussions of them exist elsewhere (Guba, 1981; Guba & Lincoln, 1981).

The Nature of Reality

The rationalistic paradigm assumes a single, objective reality that can be broken down into independently identifiable variables. Furthermore, it assumes that these variables can be manipulated and studied individually without disturbing their essential nature. Making this assumption is what allows experimentalists to study a phenomenon by holding some variables constant while artificially manipulating others. Naturalists, on the other hand, see a complex reality in which all parts influence all other parts. They are inclined to feel that if an investigator attempts to hold parts of reality constant while studying other parts, the researcher probably has destroyed the essence of the phenomenon under investigation.

The Relationship Between the Investigator and Phenomenon Studied

Rationalists assume that a researcher can study a phenomenon while maintaining independence from it; the phenomenon is not influenced by the investigator's presence, and the investigator is unaffected by the object of the inquiry. Naturalists believe that the investigator and the phenomenon influence one another. While naturalistic inquirers would seek to minimize their impace upon a phenomenon, these researchers believe that they must interact with the phenomenon in order to understand it. Furthermore, they are always aware that their presence is changing the object of their study at least somewhat and that they are in turn being influenced by their involvement.

The Extent to Which Generalizations are Possible

The rationalistic inquirer believes that research can result in generalizable truth, i.e., statements of the relationships between variables that apply in any context. This assumption tends to follow from the rationalist's belief in a single, divisible reality. Naturalists do not believe that such statements are possible. They feel, in Guba's (1981) words, "that at best what one can hope for are 'working hypotheses' that relate to a particular context" (p.77).

Methodologies

Making the assumptions presented above leads naturalistic investigators to prefer certain data gathering analysis techniques over others. Most of these techniques fall into a category generally termed qualitative. However, it should be noted that naturalistic investigators frequently make use of quantitative data; it is important not to equate qualitative methods with naturalistic inquiry. However, a discussion of the methods that characterize naturalistic studies may help the reader get a 'feel' for the conduct of naturalistic studies.

"Real World' Settings

The locus of a naturalistic study is always the 'real world', i.e., a naturally occurring setting. Naturalistic investigators confront undisturbed behavior and environments for the purpose of generating analyzable data from them. The writing of Roger Barker (1965) is pertinent here. Barker distinguishes between the role of investigator as "operator" (p.3), i.e., one who dominates the setting under study by "regulating input, and/or influencing interior conditions, and/or constraining output "(p.3), and the role of investigator as "transducer" (p.3), i.e., one who translates a phenomenon into analyzable data. Using these terms, experimentalists and traditional evaluators tend to be operators and transducers, whereas naturalists tend to be transducers only. And as Barker (1965) points out "What [transducer] methods do, [operator] methods cannot do at all: [operator] methods cannot signal behavior and its conditions unaltered by the system that generates the data" (p.4).

Absence of A Priori Hypotheses

Naturalistic inquiry is characterized by a relative absence of *a priori* assumptions about the nature of the phenomenon to be investigated. Those researchers and evaluators who are experimentally oriented specify in advance of the study those variables which they believe are most important in explaining or evaluating the phenomenon of interest. These selected variables become the foci of the investigation. Naturalists, on the other hand, enter the study with only tentative notions about what might be important, force themselves to be open to all aspects of the phenomenon before them, and then allow the relevant outcomes and most powerfully explanatory variables to emerge as the study progresses. Egon Brunswik (1956) once characterized this distinction in approach as "a successive omission" (p.24) as opposed to "a successive accumulation" (p.24) of relevant factors; unlike experimentalists, naturalists confront phenomena in all their complexity and eliminate irrelevant factors in their search for an explanation or evaluation.

Theoretical Sampling

Because of the relative absence of *a priori* hypotheses essential to naturalistic studies, these investigators cannot decide in advance every piece of data that they will collect and by what means it will be gathered. The term "theoretical sampling" (p.45) is used by Glaser and Strauss (1967) to describe the process "whereby the analyst jointly collects, codes, and analyzes his data and decides what data to collect next and where to find them, in order to develop his theory as it emerges" (p.45). This situation stands in stark contrast to that of experimentalists and preordinate evaluators who regard a detailed, a priori, description of their "design" essential to the credibility of the study.

Multiple Data Sources

Another hallmark of naturalistic investigations is the use of multiple data sources. Naturalistic inquirers are interested in any source of information that sheds light on the problem under study. Whereas experimentalists and many preordinate evaluators will decide in advance on a limited number of quantified outcome measures, naturalists may use interview data, observation logs, existing documentation, records, correspondence, and conversation as well as standardized instruments, tests, questionnaires, specific behavioral indicators, or other more readily quantified data sources. Following the practice of theoretical sampling, decisions regarding data sources to be used will be made only well after the investigation has begun. Multiple sources of information, however, will always be used.

There are two reasons for the consistent inclusion of multiple data sources in naturalistic studies. One is the natural settings in which such studies are conducted. The naturalist is interested in explaining how phenomena operate in the 'real world.' Initially the investigator must be open to all factors impinging upon the problem under study. A wide investigative net is, therefore, required; multiple sources of information must be pursued. The other reason for including multiple data sources has to do with what experimentalists call internal validity, i.e., the validity of cause and effect inferences made about the situation being investigated. A naturalist's explanation of events is strengthened by confirmation from a variety of data sources. The term for this technique of confirming validity through the cross-checking of several sources is _triangulation_. Guba (1978) draws this parallel between triangulation and statistical means. "As statistical means are more stable than single scores, so triangulated conclusions are more stable than any of the vantage points from which they were triangulated" (p.64).

Observation, Interviews, and Description

Because of its focus on complex, 'real world' phenomena, much of the information essential to a naturalistic study can only be had through observation and interviews with participants in the situation being studied. Therefore, the data of a naturalistic study are frequently copious field notes, interview transcripts, and the "thick description" discussed by Guba (1981). Contrast these data gathering techniques with those of experimentalists and many preordinate evaluators who, in effect, reduce complex phenomena to a single, quantifiable outcome. The reader should not conclude that naturalists would not be interested in, for example, test score data. As was noted earlier, naturalists tend to be interested in _any_ source of information relevant to the problem under investigation. However, the naturalist would tend to see any single data source as one to be triangulated against others; therein lies one important difference between naturalists and most experimentalists.

Value Accorded Deviant Cases and Disturbance

Naturalists are generally interested in 'deviant cases', i.e., "those instances of a phenomenon that do not fit their proposed explanation" (Shrock, in press) and changes within the ongoing phenomenon they are studying. The reason for this interest is that deviance allows the investigator to refine his/her explanation or to more accurately specify its limitations. Changes and interruptions are regarded as part of the phenomenon's nature--as events to be accommodated within one's explanation. Contrast this stance with that of experimentalists and many preordinate evaluators who seek to protect "treatments" from change or disturbance during the experiment or evaluation in order to safeguard the internal validity of their findings.

The Application of Naturalistic Inquiry to Program Evaluation: An Example

The following section of this piece is an attempt to illustrate how an evaluation looks when it proceeds from naturalistic assumptions and when the associated methodologies are used. This portion of the paper is written in the first person. Since the author was the evaluator in this example, the account is largely a personal one that seems more accurately portrayed in a less formal way. Being sensitive to the need for confidentialty in the discussion of this evaluation, I have not perhaps described the institutional setting as thoroughly as would otherwise be desired. It is hoped that the descriptions are complete enough to be illustrative of the points made, yet sufficiently vague to protect the confidentiality of the client institution.

Institutional Setting

The evaluation took place at an Eastern, four-year liberal arts university, hereafter called W.U. W.U. had acquired federal funding--hereafter referred to as a FIG Grant--to support the conversion of its curriculum from traditional to competency based instruction. Two full-time federal grant administrators were housed at W.U. to manage the project. The FIG program had been operating for about two years when I became involved with it.

During the first two years, the grant administrators had overseen several different support activities designed to accomplish the program's goals, i.e., getting the W.U. faculty to convert their courses to competency based instruction. The specific request made of me was the evaluation of a three-week, summer, faculty development workshop. The workshop was being staffed completely by external consultants in instructional development. The request for evaluation was made about two weeks before the workshop was to begin; very little advance information regarding the conversion project, the W.U. faculty, or the specific goals and activities of the upcoming workshop was available. While it is certainly true that the information available was sketchy, this situation is not unusual. Especially when the evaluator is hired from outside the client institution, it is very likely that much important information will be unavailable to him/her at the outset.

Methods of Gathering Evaluation Data

The methods of gathering information during the workshop are described briefly below.

Observation of workshop group sessions. I spent many hours during my three weeks at W.U. sitting in on workshop sessions and taking down an extensive log of what transpired. I did not assume the role of participant observer in these sessions, e.g., I did not engage in planned workshop activities or respond to questions asked of participants. During these formal gatherings, my role was to watch and to record as much as I could--interaction, planned activities, content of lectures,participants' reactions, questions, etc. The recording of this ongoing log of what occurred during the workshop turned out to be the single most valuable strategy for collecting useful information.

Structured interviews with workshop participants. Loosely structured interviews were conducted with all participants at the close of the workshop. These interviews provided information about both faculty attitudes and knowledge and allowed for some commonality in the information collected across participants. The face to face interview made possible the collection of more subtle information than could ever have been gathered via paper-and-pencil, especially regarding faculty attitudes.

Structured interviews with workshop consultants. At the close of the workshop each consultant was also interviewed using a loosely structured format. I have used the phrase "loosely structured" because while each interview was based on the same set of questions, every interviewee was allowed to respond fully and freely and take the interview into unanticipated directions.

Examination of participants' products. The course syllabi, tests, student guides, etc. produced by the W.U. faculty during the workshop became a valuable source of information about their knowledge of instructional development.

Examination of records of past FIG workshops. These materials consisted primarily of past workshop agenda and scant evaluation reports. They were used to reconstruct past workshops for the purpose of gaining some insight into the sources of faculty attitudes and knowledge about I.D.

Examination of FIG correspondence files. The correspondence files contained information about the past and proposed instructional products of faculty attending the workshop. The files were a source of information about the faculty's knowledge of I.D.

Unstructured interviews with the two FIG administrators and W.U.'s fulltime "instructional developer". During the academic year preceding the workshop, the FIG administrators had hired from grant funds a full-time "instructional developer" to plan workshops and assist the W.U. faculty with their conversion projects. His contract had been allowed to expire shortly before the summer workshop began. While he was still at the University to finish out his contract, he was not directly involved at all with the summer workshop. These three persons were excellent sources of information about the history of the FIG project at W.U. However, of the three only one of the administrators was fully cooperative in providing information. Defensiveness (understandably) tended to characterize the responses of the "developer" while the other administrator was threatened by the presence of an evaluator. When triangulated with other sources, however, the information obtained from these persons proved to be useful.

Informal observation of and conversations with participants, consultants, and administrators. Naturalistic evaluators are continually in the process of collecting data. Some of the most informative comments are inevitably made during hallway chats and over the coffee and donuts during breaks.

Data Analysis

As data collection proceeded, tentative themes were identified based upon repetition by various persons and/or in different sources of concerns, opinions, or questions. Sometimes the themes appeared to be related. In these cases, hypothetical explanations were constructed to relate the themes and account for what was being observed and/or heard. For example, participants seemed overly eager to integrate hard media--video-tape, slides, film, etc.--into their courses. During group discussions, they had difficulty conceiving various instructional strategies designed to meet the same objective. These two themes raised questions regarding how adequately the development process--of which generating instructional strategies is a component and wherein various hard media are alternative strategies--had been presented to these faculty members.

As far as was possible, 'hypotheses' suggested by the tentative explanations were checked out. Returning to the above example, examination of past workshop records revealed a comparatively heavy emphasis upon instructional media and a total neglect of any other instructional strategy. In this way, the themes suggested additional questions to be asked regarding faculty attitudes and knowledge and their sources. The concerns that survived as themes throughout the workshop became the descriptive lists of faculty attitudes and discrimination failures that ultimately appeared in the evaluation report. The explanations that related the themes and suggested their sources became the basis for the recommendations made to the FIG administrators. Returning once again to the hard media fixation example, the recommendation was made in the report that emphasis be placed upon clarifying the meaning of an instructional strategy since participant attitudes toward I.D. would reflect their attitudes toward media as long as this confusion existed.

The above paragraphs are an illustration of what was referred to earlier as theoretical sampling. One enters the situation without knowing initially what is important, i.e., what problems are present, what concerns administrators and participants have, etc. The early stages serve to address an important goal of evaluation, i.e., to determine in Bob Wolf's (Note 1) words "what is going on in the program." It may be difficult for some readers to imagine that finding out "what is going on" is a legitimate and serious goal of evaluation. Two points, however, are relevant here. The first is that frequently decision makers do not know "what is going on" in a program; describing the program accurately for them can be a very valuable service. Second, it is a serious mistake for an evaluator to assume that program decision makers do know "what is going on." Herein lies one of the major deficiencies in evaluation that borrows from the rationalistic paradigm and experimental research; because preordinate designs are considered essential, evaluators tend to rely on premature notions about what is important in a program. They accept the program spokesperson's notions of program goals, important variables, possible problems, etc. in order to specify their evaluation plan in advance of data gathering. As a result, many preordinate evaluations never reveal the true nature of the program. The results are largely irrelevant artifacts of the design.

In the course of discovering "what is going on," the naturalistic evaluator looks for themes--recurring concerns, conflicts, dysfunctional behavior, etc. If someone voices a concern to the evaluator, his/her response will be to try to determine if anyone else connected with the program shares the concern or if other data lend support to its legitimacy. The pattern of themes that emerges lead to hypotheses about their sources. Additional data collection is guided by the need to confirm or disconfirm the hypothetical explanations. Triangulation of data sources is used to establish the validity of, eliminate, or revise the tentative explanations. Those descriptions, themes, and explanations that survive this process typically become part of the evaluation results that are provided to the client or audience for the evaluation.

The Nature of Naturalistic Results

The major results of the FIG program evaluation at W.U. are presented below. I think they are typical of the kind of findings that result from naturalistic evaluations.

1. Many of the W.U. faculty participating in the workshop had no intention of ever using the developed materials in their classes; they were simply there at the workshop because of the summer stipend paid by the FIG grant to each participant.

2. An enormous amount of hostility was present between the FIG administrators and the W.U. faculty. The faculty resented the interference of the FIG program in their classes; the FIG administrators regarded much of the faculty as lazy and inflexible.

3. Many of the faculty workshop participants were under severe stress; state cutbacks in funding were necessitating faculty layoffs. Some faculty received notices of non-renewal during the workshop.

4. The FIG administrators had not always considered the large role that affect plays in the adoption of any innovation. They had offended the faculty but continued to treat the faculty's lack of performance as strictly an informational problem.

5. The quality of students recruited by W.U. had dropped dramatically during the previous decade. Many faculty members equated I.D. with the creation of instruction exclusively for low ability students. Their self-esteem was threatened by the perceived deterioration of the student body, a deterioration they felt the FIG program, and consequently instructional development, confirmed.

6. Due probably to expediency and the lack of a solid grasp of I.D., the FIG administrators evaluated the faculty's progress by counting

concrete products they created, e.g., tests, syllabi, etc. The quality of what was created was seldom addressed.

7. Because of the FIG administrators' own lack of knowledge of I.D., the W.U. faculty had been exposed to a series of misleading workshops supposedly designed to help them convert their courses to competency based instruction. Many of these workshops had been conducted by the full-time "developer" who, in fact, had very weak credentials in I.D. Records of the previous workshops partially revealed the etiology of the faculty's confusion regarding instructional development. These workshops and previously noted factors operating in the W.U. milieu had led the faculty to the following beliefs about instructional development.

a. Instructional development assumes that traditional teaching methods, e.g., lecturing, are wrong.

b. Instructional development will necessitate major changes in the way W.U. courses are taught; nothing will be the same after the 'New Order' is ensconced.

c. Instructional development is restrictive, i.e., it dictates what can be taught in a course.

d. Instructional development dictates the use of media in instruction.

e. Instructional development is a technique for creating instruction for low-ability students; there is no value in using it when instructing bright students.

f. Instructional development will necessarily lower the academic standards at W.U.; developed courses are easy courses.

g. Instructional development at W.U. will mean that bright students will receive an education of lower quality.

8. Observation of the group workshop sessions had revealed that in addition to negative affect toward I.D., the W.U. faculty had some cognitive confusion regarding the process. This confusion was analyzed extensively during the workshop and was presented in the final evaluation report as a series of specific discrimination failures as follows.

a. process/content - Faculty had difficulty separating instructional development components from the content vehicles used to demonstrate the components. In many cases participants did not realize that the I.D. process neither depends upon nor dictates course content.

b. competency based instruction/mastery learning - Many participants believed that grounding instruction in specific objectives dictated the percentage of students who must succeed. This confusion contributed to the belief that I.D. would necessitate a drop in university standards.

c. goals/objectives - Some participants saw the consultants' emphasis on specificity in instructional objectives as a denial of the legitimacy of more general and, therefore, for some purposes more useful statements about course outcomes. The failure to make this distinction caused I.D. to appear rigid and mechanistic.

d. terminal objectives/enabling objectives - The logic of hierarchies in I.D. had not been understood by many faculty members.

e. instructional objectives/instructional strategies - Participants seemed to be largely unaware of the concept of an instructional strategy, i.e., a means of achieving an instructional objective. The notion that a number of different strategies exist and that some might be better than others in achieving a given objective was foreign to many. The most common distinction made among strategies was lecture vs. media. Unfortunately, many faculty members had been led to believe that the media option was the one preferred by instructional technologists. They were not encouraged to learn about or experiment with other strategies.

f. knowledge level/higher cognitive levels - Faculty generally had trouble making this distinction in their instructional planning. They tended to write objectives at higher levels, but to write test items at the memorization level.

g. student entry behavior/student potential - Faculty members tended to dismiss students' potential based upon their lack of entry skills.

Perhaps a brief discussion of the nature of these results would be useful. They, like most naturalistic results, have the following characteristics.

Results tend to be panoramic. The results tend to pull together diverse aspects of a situation both inside and outside the immediate program being examined. In the case of W.U., extra-institutional factors such as the demographic shift in the student body, institutional factors such as faculty dismissals, past program factors such as an inappropriate focus in previous workshops, and current program factors such as an undue emphasis on concrete products were drawn together to explain why faculty at W.U. felt instructional development hastened the decline of academic standards. The scope of naturalistic results stem from the refusal to limit the focus a priori and from the multiple data sources that are always examined.

Process as well as outcome is described. Naturalistic evaluation results tend to describe not only outcomes, but how those outcomes came to be. Etiology of the major outcomes is always important. In the case of W.U., the evaluation report discussed in some detail the sources of the faculty's poor attitudes and cognitive failures. This characteristic of naturalistic findings makes them particularly useful since the explanations usually suggest recommended changes in program processes; decision makers not only know where they are in terms of outcomes, but they also have an idea of what they can do differently if they don't like where they are. This process focus of naturalistic evaluations is made possible partly by the reliance on observational date; the program's functioning--its process--is directly witnessed.

Differences in perspective are represented. Besides the perspective of the evaluator, the evaluation report written about W.U. contained the different perspectives of the W.U. faculty, the FIG administrators, and to a lesser extent, the workshop consultants. This quality of the findings proceeds from an unwillingness to accept a single, objective reality. All of these parties had a legitimate view of the W.U. world. One of the major goals of a naturalistic evaluation is to portray those differences in perspective. It is not unusual for one party to be astounded at the perspective of another party within the same program. One hopes, of course, that the portrayal of different perspectives will allow greater understanding and expedite the resolution of dysfunctional conflicts within the program. The multiple perspectives emerge, of course, because of the reliance on subjects' impressions as a data source and upon interview and observation as data gathering techniques.

Many of the findings are related to one another. Reading through the W. U. evaluation results, one finds that many of them are related to one another; for example, the cognitive and affective results at W.U. are closely related. This characteristic results from the thematic way in which naturalistic data is analyzed. The results that emerge tend to be holistic and 'hang together' supported by common themes.

Many of the results contain personally and politically sensitive material. Some of the results of the W.U. evaluation were explosive; indeed, some of them could not be reported. Such findings are not unusual in naturalistic studies. They come to light for at least two reasons. First, the role of a naturalistic evaluator is to establish rapport with program participants and decision makers. The importance of this rapport cannot be overstated; skill in building harmonious relationships quickly is an essential ability for naturalistic inquirers. Once such a relationship has been established, the evaluator finds that he/she has access to many otherwise closed sources of information. Participants trust him/her and are willing to share their feelings and thoughts. The fact that naturalistic evaluators have access to sensitive information is one of the paradigm's major strengths. Explanations that would otherwise never be revealed are sometimes made available to skilled naturalistic inquirers. The second reason why sensitive information is frequently unearthed by naturalistic evaluators has to do with their digging through multiple data sources and the omnipresent nature of their involvement with the program being studied. Like good investigative journalists, it is relatively difficult to hide information from them. Unlike preordinate evaluators who tend to limit their focus from the outset, naturalistic evaluators are constantly triangulating one source of information against another. Under such scrutiny, some aspects of the program that might otherwise be concealed become difficult to hide. The ethical questions surrounding this characteristic of naturalistic studies are many. It must suffice here to say that naturalistic evaluators - like all others - must hold themselves to the highest standards regarding the dissemination of any information which they have been privileged to receive.

Difficulties in the Conduct of Naturalistic Evaluation

For all their advantages, there are several distinct difficulties frequently encountered in the conduct of naturalistic evaluations. Three of these problems are discussed briefly below.

Credibility Problems

Because of evaluation's beginnings in tests and measurement and its alliance with the dominant research paradigm in the social sciences, naturalistic evaluations lack credibility with some decision makers. This problem is particularly severe when evaluation services are being contracted. Some clients don't understand why the naturalistic evaluator can't provide them with a design. They are simply not prepared to hear the arguments in favor of naturalistic approaches. Such arguments sound "unscientific" and "soft" to them. Credibility can still be a problem after the evaluation is finished. Since the criteria used to evaluate rationalistic studies cannot legitimately be applied unmodified to naturalistic studies (Guba, 1981), critics who insist upon using those criteria will be unsatisfied with naturalistic investigations. Guba(1981) and Guba and Lincoln (1981) have carefully addressed the appropriate criteria by which to judge the adequacy of naturalistic evaluations. However, it is not reasonable to assume that program decision makers in great numbers will become conversant in these criteria in the near future. The quantitative, rationalistic, experimental establishment has dominated for decades; the naturalistic advocates face credibility problems for some time to come.

Problems with Threat

As has been mentioned before, naturalistic evaluations take an initially broad perspective and are guided by the emergence of themes. The concerns of anyone connected with the program get a hearing. Consequently, such evaluations are difficult for program decision makers to control. Preordinate evaluations can be stringently limited from the outset; however, it is usually politically difficult for a client to stop the pursuit of a theme in a naturalistic evaluation. Furthermore, since preordinate evaluations are explicit from the beginning, they make it easier for clients who have a stake in positive results to 'play' the program to the evaluation design. During a naturalistic evaluation, such manipulation is more difficult because of the breadth of the data sources incorporated. This characteristic of naturalistic evaluations is at once their strength and one of their problems. Evaluation is a highly political activity; one should not underestimate the substantial threat posed to some clients by a naturalistic study of their program.

Time and Effort Required

Because of the intensity of involvement, the multiple data sources, extensive observation, etc., one needs serious commitment (and a great deal of energy) before undertaking a naturalistic evaluation. During such an investigation, the evaluator is always 'on.' Program events that may be recreation and relaxation for other participants are merely additional sources of data for naturalistic evaluators. They must guard against 'going native', i.e., losing their relative objectivity and forgetting their professional role. In short, naturalistic evaluations can be exhausting. However, if one has the energy and the skill to conduct such an evaluation, the results can be most gratifying. There is a certain intellectual satisfaction that comes after having approached a complex reality with a paradigm that does justice to its complexity, and walking away with understanding.

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TITLE: Effects of Imagery Form and
Instruction on Prose Learning

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EFFECTS OF IMAGERY FORM AND INSTRUCTION ON PROSE LEARNING

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A primary means for classroom learning is through written prose material (Olson, 1977). Various techniques for enhancing learning from prose material have been investigated. These include the use of pictures and the use of self-generated imagery through which learners create their own mental pictures to help them remember the prose content (Pressley, 1977).

Both provided pictures and induced images have been found to be effective in facilitating learning from text (Fleming, 1977, 1979; Pressley, 1977). The effectiveness of these strategies depends in part on the age of the children who employ them. Learners between the ages of four and seven can benefit when pictures are provided with text material (Dilley & Paivio, 1968; Dunham & Levin, 1979; Fleming, 1979). Studies also have indicated that learners by age 10 can generate their own mental images to help them remember prose material (Shimron, 1974; Lesgold, McCormick, & Golinkoff, 1975; Pressley, 1976). Once children reach an age at which they are able to benefit from either provided pictures or induced images, it is not clear which is the better text-enhancement strategy (Fry, Haring, & Lagomarsino, Note 1).

Reading ability is another factor that affects learning from prose. Differential results by reading level have been found in studies where imagery was used as a text-enhancement strategy (Levie & Lentz, in press). Several researchers have found that poor readers benefit more than good readers from the use of imagery (Levin, Divine-Hawkins, Kerst, & Guttman, 1974; Rohwer & Matz, 1975; Rusted & Coltheart, 1979). However, Levin (1972) has suggested that good readers typically perform better than poor readers under all instructional conditions.

The purpose of this study was to investigate the effects of different text-enhancement strategies on prose learning of high and low readers. Three different enhancement techniques were employed in addition to a text-only condition. These techniques were pictures, pictures with practice, and induced imagery with practice. Performance was assessed on a 29-item completion-type criterion measure administered immediately after the treatment.

Method

Subjects

Ninety-nine (99) sixth-grade students, 49 girls and 50 boys, from two metropolitan elementary schools in Phoenix, Arizona participated in the study.

Materials and Procedures

A 666-word story about the killer whale adapted from Maher and Sullivan (1982) was used for the study. The passage, which has a Dale-Chall readability index of 4.4, contained information about the appearance, characteristics, misconceptions, social behavior, and training of the killer whale. The story was divided into 22 short paragraphs of 2-5 sentences. Two paragraphs were on each page, one at the top and one in the middle.

The materials were prepared in four different forms to represent the experimental conditions:

text only (no enhancement)
text with pictures
text with pictures and practice
text with induced imagery and practice

The four levels of text enhancement were crossed with two reading levels. Subjects were classified as high or low readers based on their California Achievement Test reading scores. Subjects were blocked by reading level, then randomly assigned to the four treatment groups. The treatment groups contained from 24 to 26 students across the two reading levels.

Trained experimenters simultaneously administered the experimental treatments in separate rooms. Experimenters told subjects that they were going to read a story about the killer whale, then be tested on what they read. Instructions relevant to the particular treatment were given.

The text only form of the materials consisted of the text with no enhancement. Students in this group were told that they would be reading the story and they should try very hard to remember what they read.

The text with pictures form contained illustrations in the form of line drawings after each paragraph of the text. Students were given the same instructions as the text only group, except they also were told that they would see pictures with the story. No other reference was made to the pictures.

The text with pictures and practice form consisted of the story and line drawings, practice on using the pictures, and reminders to use them. The reminders were inserted in the materials below the drawings after the fifth, eleventh, and seventeenth paragraphs. Students first heard the same information as the text with pictures group. They were told that the pictures could help them remember information that they

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read and were also told how to use the pictures to remember. Next, students were given three practice sentences with pictures. Questions were employed as prompts so that students would use the provided pictures to help them remember the practice sentences. After the practice sentences, students read the killer whale story with pictures. The text included the following reminders to use the pictures:

> Remember to use the pictures to help you remember what you read.
>
> Remember: use the pictures to help you remember what you read.
>
> Don't forget to use the pictures to help you remember what you read.

The text with induced imagery with practice form was comprised of the story, practice to induce images, and reminders to use them. The reminders were inserted after the fifth, eleventh, and seventeenth paragraphs. Students were given similar instructions as the text with pictures and practice group. However, rather than looking at provided pictures, the students were instructed to "make a picture in your mind of what you read." Students practiced inducing images with the same three sentences as the text with pictures and practice group. After practicing, the students read the killer whale text. The text included reminders which were as follows:

> Remember to make pictures in your mind to help you remember what you read.
>
> Remember: make pictures in your mind to help you remember what you read.
>
> Don't forget to make pictures in your mind to help you remember what you read.

Criterion Measure

The criterion measure consisted of 29 completion items designed to measure factual recall. The items were derived directly from the text information and randomly ordered. Test-retest reliability of the criterion measure, computed from an earlier study (Maher and Sullivan, 1982), was .94.

Data Analysis

Data were analyzed using a 4 (text enhancement form) X 2 (reading level) analysis of variance with the criterion test score as the dependent variable. In addition, contrasts were performed to examine observed differences in mean scores by treatment group and reading ability.

Results

Mean scores on the criterion test are shown by treatment in Table 1. The greatest difference for main-effect comparisons was between high and low readers. Total mean scores were 22.18 for high readers and 17.02 for low readers, $\underline{F}$ (1,98) = 25.02, $\underline{p} < .0001$. Scores by text-enhancement strategy ranged from 20.89 for induced imagery with practice to 17.76 for no enhancement, but neither the main-effect difference for text enhancement nor the reading level by treatment interaction were statistically significant.

The pattern of mean scores among treatment groups differed for the high and low readers. Mean scores of high readers varied only slightly across the four groups, ranging from a low of 21.42 to a high of 23.31. In contrast, among low readers, the text-only group scored approximately five points lower than each of the other three groups. The mean for the text-only group was 13.36 (46 percent), whereas the means were above 18 for the low readers in the other groups.

Tests of contrast among the low readers revealed a significant difference between the mean of the text-only group (13.36) and the combined means of the other three groups (18.24), $\underline{F}$ (1,48) = 5.38, $\underline{p} < .03$. A comparison of the mean for the text-only group with that of the induced imagery with practice group mean (18.46) was significant, $\underline{F}$ (1,48) = 4.12, $\underline{p} < .05$. Comparisons between the text-only group with the pictures-only group and the pictures with practice group approached statistical significance, $\underline{F}$ (1,48) = 3.52, $\underline{p} < .07$ for both comparisons.

Discussion

The purpose of this study was to compare the effects of text-enhancement strategies on the learning of written prose material by sixth graders. The text-enhancement strategies of pictures, pictures with practice, and induced imagery with practice did not have a significant effect that extended across high and low readers. As expected, high readers performed significantly better than low readers.

The data indicate that text enhancement may be more effective with low readers than with high readers. The mean score of high readers in the unenhanced text group differed only slightly from each of three other groups. However, low readers in the unenhanced text condition scored appreciably lower than those in each of the three text-enhancement conditions. The percentage scores for high readers (76%) and for low readers (46%) in the unenhanced text condition illustrate the difference in performance of high and low readers and the greater potential for improvement among low readers. The mean score of 46% for low readers in the unenhanced text condition was considerably lower than the mean percentage scores (62% - 64%) for the three other groups of low readers that received some form of text enhancement. High readers may have learned the material well enough in a single reading that text enhancement contributed little or nothing to their performance. In contrast, the performance of low readers leaves considerable room for improvement. The present results suggest that text-enhancement strategies may improve the overall performance of low readers.

The potential effectiveness of text-enhancement techniques for low readers merits further investigation. This study involved only a single age group and set of materials. Whether the effect would be attained consistently with low readers of other grade levels or with other materials is not clear. Further investigation across age and type of school content should indicate the generalizability of this pattern.

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Table 1

Posttest Mean and Percentage Scores by Reading Level and Text Enhancement

	Reading Level		
Text Enhancement	High	Low	Totals
Pictures with practice	21.83 (75%)	18.17 (63%)	20.00 (69%)
Pictures only	21.42 (74%)	18.08 (62%)	19.75 (68%)
Induced imagery with practice	23.31 (80%)	18.46 (64%)	20.89 (72%)
No enhancement	22.15 (76%)	13.36 (46%)	17.76 (61%)
Totals	22.18 (76%)	17.02 (59%)	19.60 (68%)

N = 99 Cell sizes range from 11 to 13.

Maximum possible score = 29

TITLE: Classroom Use of Microcomputers in Ontario:
Teachers' Views on Equipment, Software and Support

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CLASSROOM USE OF MICROCOMPUTERS IN ONTARIO: TEACHERS' VIEWS ON EQUIPMENT, SOFTWARE AND SUPPORT

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TVOntario
Office of Development Research
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CLASSROOM USE OF MICROCOMPUTERS IN ONTARIO:
TEACHERS' VIEWS ON EQUIPMENT, SOFTWARE AND SUPPORT

INTRODUCTION

Although there is a great deal of enthusiasm about the use of computers in education, at present only a small proportion of Ontario teachers are actually using microcomputers in their classrooms. Their experience with this new technology can provide a valuable guide for future developments.

Last winter we asked a sizeable number of these computer-using teachers to describe and comment on their situation, their satisfactions, dissatisfactions and concerns. Because of the exploratory nature of the study and the desire to tap teachers' experience and perspective, our questionnaire was designed primarily to elicit subjective reports and secondarily to generate statistical findings.

Sixteen questions asked about teachers' training and the length of their experience in using microcomputers, about the subjects in which they use computers, the hardware they use, the software they use, their classroom use of computers, the difficulties they encounter and their computer-related needs.

No complete listing of Ontario's computer-using teachers is available so that random sampling procedures were not possible. Instead, we sought a large and diverse sample that would comprise a substantial proportion of the relatively small world of teachers who use computers. Our contacts with school board officials and our familiarity with the distribution of computer equipment led us to select 37 of Ontario's 125 school boards. Officials in these boards were asked to distribute a total of 1300 questionnaires; almost 700 teachers completed questionnaires and returned them to us.

Since these teachers are located proportionally in all six regions of the province, in large and small school boards and in public and Roman Catholic separate school boards, we feel confident in generalizing our findings. Estimates indicate that these teachers comprise upwards of 10% of Ontario's computer-using teachers, adding further to our belief in the findings' accuracy.

The newness of computers as a classroom tool appears clearly in the figures below. Almost half of the respondents have been using computers in their teaching for less than 6 months and two-thirds have started using them within the last year.

LENGTH OF RESPONDENTS' EXPERIENCE USING MICROCOMPUTERS

Under 3 Months	21%	67% Under 1 Year
3 - 6 Months	26%	
6 - 12 Months	20%	
1 - 2 Years	22%	
Over 2 Years	11%	
	(N=694)	

Source: TVOntario, Office of Development Research, May 1982

MICROCOMPUTER EQUIPMENT IN THE CLASSROOM

In Ontario, Commodore PET's account for 81% of schools' computers, 10% are TRS-80's and 8% are Apples. In secondary schools, fully 90% of the micros are PET's, compared to 76% of elementary schools' computers.

Half of the teachers in this survey reported no technical problems with their equipment while half gave a large assortment of technical problems. Heavy classroom use resulting from too many students using too few micros was seen as the major cause of such mechanical problems as belts slipping, chip becoming loose or blowing, plug pins coming loose and micros overheating.

The most commonly mentioned problems were related to cassette recorders. Dirt accumulating rapidly in cassette heads, poorly duplicated tapes and discrepancies in head alignments were all mentioned frequently.

The following table shows the percentage of teachers who have each type of peripheral.

TYPES OF PERIPHERALS

	Elementary	Secondary	All Levels
Cassette Recorder	88%	92%	90%
Disc Drive	26	66	43
Printer	25	76	47
Game Paddles	11	9	10
Sound	3	2	3
Peripheral Sharing Networking	1	8	4
Other[1]	5	11	8
	(N=383)	(N=294)	(N=677)

Source: TVOntario, Office of Development Research, May 1982

Printers that are slow and problems with peripheral sharing networks accounted for a number of teachers complaints. Delays in having repairs done and repaires done poorly were also mentioned repeatedly.

However of greater concern to teachers than equipment failures or inadequate repairs was the shortage of equipment. Fully 83% of respondents said that they did not have enough microcomputers for their classroom needs. Many teachers felt that is is impossible to do much positive work with one micro in a class of 30 students. A ratio of 1 micro to 2 students was often seen as ideal, although some teachers would like 1 micro per student. Several comments suggested that the shortage of micros might lead teachers to give up in frustration.

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[1] Includes monitors, modems and card readers.

MICROCOMPUTER SOFTWARE IN THE CLASSROOM

Subject Areas in Which Microcomputers are Used

Overall, 57% of our respondents teach at the elementary level and 43% at the secondary level.

At the elementary level, 80% of our respondents use micros in teaching mathematics and 64% in teaching English. A smaller but still substantial proportion of teachers (12% to 16%) report using microcomputers to teach computer literacy or computer science, to teach social studies, or related subjects (family studies, environmental studies, geography, etc.) or to provide several types of special education.

Microcomputer use in other subject areas is still relatively rare. Seven percent of our respondents use micros in teaching science and 5% or less mention French, library science, industrial arts, visual arts, foreign languages and music.

PERCENTAGE OF ELEMENTARY LEVEL RESPONDENTS WHO USE COMPUTERS IN EACH SUBJECT AREA

Mathematics	80%
English	64
Computer Studies	16
Special Education	16
Social Studies	12
Science	7
French	5
Library Science	5
Visual Art	2
Industrial Arts	2
Foreign Languages	1
Guidance/Counselling	1
Music	1
	(N=383)

Source: TVOntario, Office of Development Research, May 1982

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At the secondary level, computer use is even more highly concentrated in a smaller number of subject areas.

Computer science (reported by 50% of secondary school respondents), math (31%) and business studies (29%) account for most computer use in secondary schools. Micro use in teaching science is more common at the secondary level (15% compared to 7% among elementary teachers) but computer use in other subjects areas was generally lower among secondary school teachers.

PERCENTAGE OF SECONDARY LEVEL RESPONDENTS WHO USE COMPUTERS IN EACH SUBJECT AREA

Computer Studies	51%
Mathematics	31
Business Studies	29
Science	16
Social Studies	5
Special Education	5
English	4
Library Science	4
Industrial Arts	3
French	2
Foreign Languages	1
Guidance/Counselling	1
Art/Music	1
	(N=294)

Source: TVOntario, Office of Development Research, May 1982

Types of Software and How They Are Used

The types of software readily available and the quality of existing software shape the ways that computers can be used in the classroom.

Drill and practice programs and game programs are most widely available. Their use is reported by a large proportion of teachers, especially at the elementary level.

TYPES OF SOFTWARE USED

	Elementary	Secondary
Drill and Practice	94%	55%
Games	86	53
Simulations	43	54
Tutorials	28	23

Source: TVOntario, Office of Development Research, May 1982

Simulations that approximate real-world experience and tutorials that teach concepts are more difficult to design and program, and are therefore less readily available. Four percent of elementary teachers and 7% of secondary school teachers added word processing software to the types listed in the questionnaire.

Teachers were asked how they use computers in subjects other than computer science or computer literacy. At both levels, but especially in elementary classes, micros are often used to provide either enrichment or remedial experiences for students. Drill and practice and game programs lend themselves readily to this type of use.

TYPES OF CLASSROOM USE

	Elementary	Secondary
Integral part of lesson	34%	46%
Remedial tool	87	50
Enrichment	87	61
Reward/recreation	76	37
Classroom management	16	47

Source: TVOntario, Office of Development Research, May 1982

Among secondary school teachers, fewer than half (46%) are using micros as an integral part of their lessons, and at the elementary level, only 1 in 3 of our respondents is doing so.

Comparing respondents in different subject areas, we find that a greater proportion of science teachers in both elementary and secondary schools have tutorial and simulation software and as a result they more often use their micro as an integral part of their teaching. Forty-four percent of elementary science teachers and 67% of secondary science teachers are doing so.

The following table shows that the percentage of teachers who use their micros as an integral part of their teaching increases among those who use more complex types of software.

PERCENTAGE OF RESPONDENTS WHO USE MICROS AS AN INTEGRAL PART OF THEIR LESSON

	Elementary	Secondary
Games	33%	40%
Drill and Practice	34	49
Simulations	44	57
Tutorials	46	71

Source: TVOntario, Office of Development Research, May 1982

It seems that the widespread use of computers as a central educational tool will not occur until more sophisticated software is available.

Computers are also used by teachers to perform a variety of administrative chores. The use of micros to assist in classroom management and record - keeping tasks is reported by 45% of secondary school teachers and 15% of elementary teachers. At the elementary level, 7% of teachers who have been using micros for less than six months are using them for classroom management, while 30% of those with more than one year of experience are doing so. The proportion of secondary school teachers who use their micros for classroom management increases from 35% among the less experienced to 58% among the more experienced.

Software Availability

At the elementary level, 70% of computer-using teachers have difficulty finding suitable software. Although this percentage remains high in all subject areas, a higher percentage of elementary teachers in mathematics, English and special education are able to find suitable software, compared to their colleagues who teach social studies, computer science or general science.

An even higher percentage of secondary school teachers (76%) have difficulty finding suitable software. This is almost uniformly the case across all subject areas, although secondary-level computer science teachers are least likely to have difficulty while the shortage of software for English, special education and social studies is especially acute.

Since computer software is a new type of learning material, the means for distributing it are just now being developed. To a large extent, the onus is still on the individual teacher to locate it.

At the elementary level a majority of teachers receive software through resource people at their board or school. At the same time, two-thirds of elementary teachers copy software themselves and one-third locate it themselves and ask that it be purchased.

At the secondary level, copying software is the predominant mode. Half find software on their own and less than half use board or school resources. One quarter of secondary school respondents write at least some of their software themselves.

ACCESS TO SOFTWARE

	Elementary	Secondary
Through resource person in school	26%	10%
Through resource person at board	69	41
Find it on one's own	34	50
Copy	66	73
Write	11	25
Other sources	15	17

Source: TVOntario. Office of Development Research, May 1982

The Quality of Software

Teachers select from available software the programs they will use with their students. In judging the quality of software, 56% of elementary teachers and 49% of secondary teachers are less than satisfied with the software they are using. Although this percentage remains fairly uniform across all subject areas, some differences do exist. The subjects in which few teachers are using micros and software is not readily available are also the subjects in which software quality is less satisfactory. These include computer science and general science at the elementary level, and English, social studies and special education at the secondary level.

Teachers who are not satisfied with the quality of the software they are using -- roughly 50% of our respondents -- commented extensively on their concerns. Software was described as "simplistic," "repetitive," "dull," "not professional," "insulting," "having insufficient variety," "inauthentic," "unrealistic," "unsophisticated," "inappropriate," and not designed to "promote critical thinking."

In addition to the overall poor quality of a great deal of the software, teachers are concerned with the educational irrelevance of the software to school curriculum. Software was described as "not task specific," "not suited to my needs," "not suitable for the grade being taught," and "not compatible with the curriculum." The phrases "doesn't apply to my courses," and "doesn't do what I need it to do," appear frequently.

Teachers also say that software is "limited in scope and depth," "just a video textbook," "not rich enough," "not Canadian-oriented," "not educator-evaluated," "too general," "poor pedagogically," and has "too much busy work." One teacher commented that "80% of all software we receive is useless for classrooms."

Many teachers commented that documentation and/or instructions accompanying software were incomplete, confusing and vague, especially for elementary students. Software was often described as being "full of bugs." Teachers' attempts to break in and clean it up or modify it often result in losing the program. Programs "crash" too easily. They are described as not being "student-proof," in that many students don't run them easily and require considerable teacher assistance. In many programs students can't see where they went wrong because the feedback given is poor.

Teachers were dissatisfied when they were unable to preview or test mail-order software, when they were unable to return unsatisfactory software or when they were unable to afford the cost of some good quality software. The lack of good publications containing software descriptions and reviews was mentioned frequently.

Software Needs

Teachers were asked what kinds of software they need in the subjects they teach. Their most frequently expressed need is for software that is consistent with Ontario curriculum courses of study.

A large number of teachers expressed needs for "tutorial" or "instructional" software. This would be used to present basic lessons or cohesive units of lessons and would free the teachers to deal with the "personal side of teaching." Ideal tutorial software would be "conceptual," "motivational," "open-ended," and "naturally interactive." It would contain "good graphics," and "imaginative simulations." It would "stimulate creative thinking" and "make the students supply solutions." It would support the child in an "individualized, self-teaching" style, to understand "theoretical principles," through "sequential modules."

Another group of comments centred on the need for good "self-correcting" or "diagnostic" software to help students pinpoint areas where they need help and see their problems and mistakes. Some teachers requested tutorial software with "built-in tests and reviews" but others saw this kind of function as separate from "instruction." "Review" or "skill-and-drill" software was perceived as necessary and useful to reinforce skills and to provide remedial help for students having difficulty with conceptualization.

Smaller numbers of teachers expressed needs for:

- authoring programs that allow teachers and students to create their own programs and lessons;
- software for classrooms and school management programs that keep student records, timetable classes and organize school events;
- good documentation and manuals that assist teachers in applying software;
- simplified software for students whose first language is not English; and
- software to teach programming in languages other than BASIC, such as Structured BASIC, COBOL.

In their comments, teachers described not only the kinds of software they need, but the related services that would provide access to good software. Once it is produced, software should be pre-tested, reviewed and evaluated. Catalogues of software and software reviews should be available easily. A provincial newsletter or similar publication describing and evaluating the best in curriculum-related software was suggested frequently. Centralized banks of software in board or school resource centres were also suggested. Ideally these would make it easier for teachers to find, preview, and use all available software.

TEACHER TRAINING AND SUPPORT IN MICROCOMPUTER USE

Learning to Use a Microcomputer

With little of the resistance met by such new technologies as ballpoint pens or electronic calculators, microcomputers have entered the schools very swiftly, and often with little preparation. As yet there has been no comprehensive plan for training Ontario teachers in their use and, with the exception of very few boards, teachers are not required to have any organized training before using microcomputers in their teaching. One teacher wrote, "Education is probably the only industry which demands that the computer will be used and that people using computers must train themselves, at their own cost, outside of the work place and work time."

In fact, 28% of our respondents have had no organized training whatsoever. Thirty-six percent have taken one or more courses sponsored by their board or by the Ministry of Education. These courses range from 2 hours at a professional development day up to 50 hours on evenings or weekends during a full semester.

TYPE OF TRAINING RECEIVED BY TEACHERS USING MICROCOMPUTERS

Board or MOE sponsored course	36%
Continuing education course	20
University credit course	10
Other courses	6
No organized training	28

Source: TVOntario, Office of Development Research, May 1982

Two teachers in 10 have taken a continuing education course at a college or university and half that number have taken university credit courses, often in computer science, with little or no specific reference to microcomputers or their use in education. Six percent of respondents have taken courses offered by manufacturers, dealers, or consultants.

If we compare the training received by teachers who are new micro users to the training of those with more experience, we find that the percentage of teachers with no organized training whatsoever has declined somewhat from 34% of experienced users to 27% of new users.

Microcomputer Clubs

Many microcomputer users have found it worthwhile to organize clubs where they can exchange information and keep up to date on new developments. This has been the case for computer using teachers as well, especially in large urban centres. More than half of respondents in large school boards belong to computer clubs, primarily to clubs organized by school boards or teachers' groups. In small boards, only 1 teacher in 5 belongs to a computer club.

CLUB MEMBERSHIP

	Large Boards	Small Boards
Board sponsored or teachers' clubs	37%	8%
General users' clubs	13	10
Other clubs (ECOO, PILOT, etc.)	6	3
Does not belong	45	80

Source: TVOntario, Office of Development Research, May 1982

Their reasons for belonging to computer clubs are quite pragmatic. Teachers indicate that they use computer clubs as a place to share, evaluate and copy software; to exchange ideas and information about classroom applications of microcomputers; to keep up with new developments in hardware and software; and to meet other computer users socially and "talk shop." A number of respondents without access to a club said they would belong if they had the opportunity.

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In-Service Training and Support

A large number of general comments at the end of the questionnaire expressed the need for on-going training, for support and recognition.

Teachers' comments indicate that training has been left for them to find on their own. School boards have provided them with little in the way of texts, manuals, or other literature about microcomputers and their educational applications.

Many teachers are asking for cohesive, organized, in-service training for all aspects of microcomputer use -- for training on how to operate equipment, how to read and run programs, how to de-bug, improve, modify and revise programs to suit their classroom needs, how to use programs effectively, and how to write their own programs when and if necessary.

Some respondents want to become more proficient in programming. Others would prefer to leave time-consuming programming tasks to professional programmers who will consult with them and take their teaching needs into account. Many teachers would like the opportunity to participate in a programming team.

The daily pressures of preparation, classroom teaching and administrative routine leave teachers no time to experiment and learn to use the microcomputer to either their own satisfaction or the students' optimal learning. Teachers comment frequently that using computers is "time-consuming." They use the term in connection with accessing micros for their classroom, with not having enough micros to go around and with searching for suitable software. They find that they don't have enough time to get training, to think, to modify programs, to organize and test micro applications, or to work on integrating micros into their teaching.

Teachers want their school boards and administrators to recognize and support their efforts to integrate this new technology into education, and to provide them with the means and time to do so.

Several teachers mentioned concerns that have not yet been discussed. Some teachers expressed degrees of uncertainty about whether they are using micros in "the right ways." They feel a need for a clear educational philosophy of how to integrate and apply micros in education. Some felt a need for a clear and uniform terminology so that terms such as CAI, CAL, courseware, software, and computer literacy have consistent meanings. There were comments on the need to study the societal impacts of computer technology. Other concerns included the development of safety standards and the need to guard against sexism.

In their comments, many teachers talked about the computer's potential as an exciting and valuable aid in helping students learn. Most teachers are impressed with the ability of micros to motivate and stimulate students, to develop students' problem solving abilities, to increase self-discipline, to challenge students to do their best while allowing them to more fully enjoy their learning. Several teachers told of their success in using computers to teach children with learning problems, behavioural problems or physical handicaps.

Our survey respondents reported a wide variety of concerns. Their frustrations with equipment shortages, with inadequate software and with the almost complete absence of organized training and support are severe. Yet their enthusiasm about the value and potential of this new technology has clearly outweighed the hardships.

CONCLUSION

Microcomputer use at the moment is largely concentrated in a few subject areas -- those where computer use is being taught (computer studies, business studies), and those where software is most readily available (elementary mathematics and language arts). In other subject areas, computer use is minimal because of the scarcity of software.

Furthermore, the software that is now available is generally unsophisticated. Much of it has been designed to provide practice and testing in basic skills, not unlike paper-and-pencil exercises with the additional advantages of interaction and immediate feedback. As a result, computers are used primarily to provide enrichment and remedial experiences for students.

Teachers can find very little of the software they are looking for, that is software that uses the computer's capabilities creatively. Ideally, this software will provide new types of learning experiences for students, while relating closely to existing curriculum content and objectives. Such software will also be designed to stimulate students' problem-solving skills and their creative abilities. The widespread use of the computer as a substantial educational tool awaits the development of such software.

Teachers who are now using computers reported at great length on both the potential of computer technology and the difficiulities of using it, given the limited amount of both hardware and software now available. They also detail the kinds of in-service training and support essential to teachers if they are to use micros skillfully. As the number of computer-using teachers grows to include not only the enthusiastic but also the hesitant, the need for such services will become even more crucial.

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Introduction

Neurological research is engendering many provocative ideas concerning the nature of the human brain. The research is an interdisciplinary effort which encourages a broader conception of man and his capabilities and complexities.

Split brain research with patients whose hemispheric brain connections have been severed shows that the brain can function in both a specialized and a coordinated fashion. Researchers are discovering that there are many ways of knowing - the logical and the intuitive, the linear and the wholistic and the verbal and the non-verbal.

The research is generating a lot of interest and, due to its complexity, both misunderstanding and abuse. Some teachers have found in it a magic panacea to cure the ills of the educational system. Their interest in brain research is related to the belief that the whole educational system is stifling creativity. They see creativity as the prerogative and essence of man. Many equate it with right brain activity, a conclusion which is not supported by the research.

A major cause of the misunderstanding and abuse of this research by educators stems from the uncertainty of whether to use the brain as a metaphor for learning, or whether to try to explain learning in terms of actual neurophysiological processes. There are physiological processes that affect learning. They exist empirically. However, the links between these brain processes and much of human behavior remain to be defined. On the one hand, educators can attempt to explain learning is terms of neurological processes. However, because for the most part these processes are extremely complex and poorly understood even by neurophysiologists, there is a danger that they will be oversimplified by educators, leading to a misunderstanding of how these processes might be linked to learning. Only in some automatic processes, which learners are not even aware of, such as arousal, is the link between neurological processes and learning better understood. We will explore some of these. On the other hand, educators can treat the brain and its processes metaphorically. This means that terms such as "right brain" come to stand for constructs such as creativity or simultaneous processing. However, this does not necessarily mean that creativity resides exclusively in the right hemisphere. Even if it did, one questions the usefulness of this information for educators. Knowing where in the brain some piece of information is processed is useless unless the educator can control where the processing takes place. This the educator cannot do, and probably will never be able to.

What this paper seeks to do is to clarify the relationship between the metaphorical and actual role the brain plays in human learning. In so doing, it will implicitly point out the folly of educators' overzealous quests for a "hard science" upon which to base instructional practice, and the dangers of attempting to build a theory in which abstract non-physiological constructs, like creativity, are mingled with the physiological without the links among them being known or even knowable. We begin with an analysis of creativity and how educators have attempted to relate it to split-brain research. We point out how the interpretation of this research has been misleading. We then turn to Luria's model of the brain as a more complete and more useful metaphor for educators. Within his model, we look at arousal, coding and planning functions, each of which has a role to play in learning and the design of instruction. Only in the case of arousal will we spend any time with neurophysiological processes. There are two reasons for this. First, physiological processes are complex and difficult for anyone who is not familiar with basic neurophysiological research to understand. Second, as we mentioned above, it is only at this low level of automatic processing that the links between physiology and learning are understood. We conclude that the brain is only useful as a metaphor for instruction and design, except possibly in these automatic processes. Educators should not base their actions upon processes and principals that are not understood.

Illustrations of various aspects of the brain are attached to the end of the paper. The reader may wish to remove these for easy reference during what follows.

Split Brain Research

The Problem

In an attempt to solve the plethora of modern educational problems, some teachers have turned to neurological research in order to discover important and novel elements from which to build a new philosophy of education. Many believe that the solution is to "educate the right brain" and thus liberate its treasure of creativity. Although an open-minded attitude and desire to improve the educational system are laudable motivations, some of the currently fashionable ideas regarding the application of brain research to education require more critical assessment.

Perceptive teachers are becoming increasingly sensitized to the difference between the kind of instruction that demands conformity and parrotting of disjointed information, which often has little relevance for the child, and true education, which encourages a flexible mode of behavior, whereby a person intuitively takes the responsibility to seek out the skills and knowledge that he requires. The latter approach is a form of intellectual karate needed to cope with the wondrous and intimidating technical and information revolution that is the hallmark of our century. Although a more creative approach to teaching is intriguing and necessary, it opens a Pandora's Box of contentious issues that would require the wisdom of Solomon to solve. These include: allowances for individual learning styles, the conflicting expectations of divergent and convergent thinkers (particularly if the teacher is one type and the student the other), the utility of having a common core of knowledge in a given subject, the necessity for some sort of evaluation, demarcation of the fine line between innovation and anarchy, etc. Many teachers believe that by encouraging creativity, which is frequently referred to by them as right-brain activity, a child can grow as an individual, receive much more emotional and intellectual satisfaction from school, and be better able to cope with the changes wrought by technology. Consequently, brain research for some educators has become the seminal material from which to formulate the new intellectual tools needed for Space Age Man.

Creativity

What is this elusive and enigmatic quality called creativity? "Every creative act involves. . .a new innocence of perception, liberated from the cataract of accepted belief." (Koestler in Edwards, 1979, p.26). A creative person intuitively transforms ordinary data into a new creation, behavior which is made possible because he has the capacity to form broad, flexible categories or schemata and "images of wide scope" (Gruber, 1981, p.69). Some the characteristics of a creative person are: curiosity, divergent thinking, a sense of humor, persistence, a high level of aspiration, independence, resourcefulness, courage, and radicalness. These characteristics can be construed as being socially disruptive and thus creative persons are often persecuted. For example, Socrates was put to death, Einstein mocked, Darwin considered an enemy of Christianity and Galileo imprisoned (Demos & Gowan, 1967, p.5). One can only speculate about the number of potentially creative talents that have become atrophied due to societal displeasure.

Do we promote creativity in schools? Razik (1970, p.160) says "The usual practises in school not only neglect creativity; they damage it." Anderson (Steinberg, 1967, p.117) goes even farther when he states that

> In children, creativity is a universal; among adults it is almost nonexistent. The great question is: What has happened to this enormous and universal human resource?

This is the question and the quest of our age.

Perhaps one reason for the dearth of creativity is that institutions and societies do not tolerate much deviation, particularly from the young. The creative child is often an anathema because he has an independent and divergent style of thinking and an idiosyncratic mode of judging his behavior, which often places him at cross-purposes with a more conventional and convergent-thinking parent or teacher. From the point of view of the harried teacher, a creative child can be an obstructionist and an irritant, who asks impudent questions at inconvenient times. For the purposes of evaluation, it is much easier to mark a composition about pinto ponies than one on purple ponies and iridescent butterflies. Many educators, at whatever level, have a lot of problems with creativity as they laud it in theory but fear and suppress it in practice because they feel threatened and inconvenienced by it. One major problem in encouraging more creativity in education is that there exists a kind of vicious circle - that primarily creative people are able to tolerate and appreciate creativity in others.

It is difficult to measure creativity objectively, and to evaluate some aspects of it would be like trying to measure infinity with a yardstick. Furthermore, the most common tests administered in schools measure facts and intelligence, which require convergent rather than divergent thinking. Getzels and Jackson (Razik, 1970, pp.160-61) believe that intelligence tests are biased against the creative child who has something more than intelligence tests reveal. Torrence (Razik, 1970, p.160) suggests that these tests miss about 70% of our creative students and that after 120 I.Q., there is no correlation between intelligence and creativity. Furthermore, researchers in the field are uncertain whether creativity is a collection of traits or a process, an aptitide or an attitude. It is more difficult to cultivate a talent if merely the manifest symptomology and not the etiology is known. Nonetheless, many studies indicate that creativity can be encouraged and fostered by parents and teachers, particularly in the earlier years (Torrence, 1967; Thorne, 1967; Williams, 1967; Walker, 1967; Guildford, 1967). Despite the difficulties, many educators are attempting to encourage the development of creativity in their students. However, unlike the views held by many teachers, scientific studies on creativity do not describe it as a right-brain activity, rather they say "A fact is discovered, and a theory is invented, but only a masterpiece is created - for creation must engage the whole mind." (Demos & Gowan, 1967, p.1).

Rogers (1970, pp.137-54) also has a number of perceptive comments regarding creativity. He believes that our education produces conformists rather than creative and original thinkers, many technicians but few true scientists who are able to formulate fruitful theories and hypotheses. He implies that the ultimate death knell of creativity occurs in graduate school where the students are given little opportunity to pursue their own interests (Rogers and Coulson, 1969, 169-202), and are sometimes required to analyze ad nauseam some minute and often trivial concept in an increasingly convergent and conventional fashion. Rogers says (1970, p.138)

> In a time when knowledge, constructive and destructive, is advancing by the most incredible leaps and bounds into a fantastic atomic age, genuinely creative adaptation seems to represent the only possibility that man can keep abreast of the kaleidoscopic change in his world. With scientific discovery and invention proceeding, we are told, at a geometric rate of progression, a generally passive and culture-bound people cannot cope with the multiplying issues and problems. Unless individuals, groups and nations can imagine, construct and creatively revise new ways of relating to these complex changes, the lights will go out. Unless man can make new and original adaptations to his environment as rapidly as his science can change the environment, our culture will perish. Not only individual maladjustment and group tensions but international annihilation will be the price we pay for a lack of creativity.

The above issues have prompted conscientious and sensitive teachers to seek methods of improving the educational system particularly by fostering creativity, which some of them define, mistakenly in our opinion, as a right brain activity.

Claims and Proposals Made by Educators

The educators who advocate that the right brain be given prominence in education like to quote Sperry (Regelski, 1978, p. 19) who says that the

> message that emerges from the findings on hemispheric specialization is that our educational system and modern society generally (with its very heavy emphasis on communication and on early training in the three Rs) discriminates against one whole half of the brain. . .the nonverbal, nonmathematical, minor hemisphere, which, we find, has its own perceptual, mechanical, and spatial mode of apprehension and reasoning. In our present school system, the attention given to the minor hemisphere of the brain is minimal compared with the training lavished on the left, or major, hemisphere.

Betty Edwards (1979), an art teacher, was disturbed by the poor drawing skills of her students and she proceeded to find innovative methods to rectify the deficit. In a somewhat simplistic interpretation of Sperry's research, she decided that the crucial factor needed for improving drawing capabilities was a cognitive shift from the logical left brain processing to the creative right brain mode. The left hemisphere should be "switched off" during art activities because it is purported to interfere with drawing, imagining and intuitive activities. Edwards believes that a child's drawing capabilities atrophy at age ten, coinciding with the more sophisticated language development that is due to brain lateralization. Translating perceptions into words inhibits the special kind of perception needed for drawing. To avoid this, Edwards developed a unique and successful art program; training her students to draw by using negative space, their left hands, or by turning the page upside down.

Another theorist somewhat conceptually similar to Edwards is Robert McKim (1972), whose ideas revolve around imagery and creativity. He places heavy emphasis upon non-verbal polysensory image formation in thought, whether it be abstract and logical or fanciful. After a complicated gestalt has been formed from non-verbal imagery, then words and signs have to be sought laboriously in the next stage of thinking. McKim also divides the brain into the logical left and the creative right, but advocates that the functioning of the two should be synchronized and fully utilized to give a "whole" human being. Sensory imagination and symbolic thinking are complementary, each performing mental functions that the other cannot. There should be a "recentering" of perception, a kind of "unlearning and unlabelizing," to permit the individual to see things in a creative, innocent, right brain way. He suggests "idea-sketching", a kind of abstraction ladder, whereby a vague and illusive image that accompanies a new idea is sketched to become tangible and communicable to others. In essence, he is describing the creative process, and he allots much attention to Einstein and other creative people who made their discoveries in a non-verbal fashion after a dream or during a sudden flash of insight.

Regelski (1978) says that true education is not learning specific facts, easily forgotten, but "is the attitudes, values, habits and tendencies made possible by the full cooperation of all mental facilities." Since students are forced to learn facts for exams, which have no relevance to their lives, they quickly forget what has been learned. In the area of the arts, he feels that excessive verbal-analytic processing is harmful and that wholistic brain processing is needed. Learning must also be related to situations that a learner might encounter in life.

In contrast to the above, Fagan (1979) condemns the simplistic theories of the right-brain advocates. He says good educators have for decades attempted to educate the "whole child", taking advantage of his unique learning styles, talents and creativity. Many excellent ideas have come from advocates of creativity, and these do not have to be defined in terms of laterality. For example, Lytton (1971) would encourage a more creative and flexible use of knowledge, whereby children would be given an opportunity to "discover" as well as "remember" facts, play with ideas and learn that one question could have several answers. Most important of all, children must feel that their ideas have value. Teachers and parents should be supportive rather than critical of many youthful ideas. Papert (1980) would add that computerized learning, particularly with LOGO (an interactive, user friendly computer language), is a very powerful conceptual tool because in the process of seeking the correct answer (the "debugging stage") the child would engage in much creative thinking as well as learning to respect the power of his ideas.

Brain Lateralization Studies

What is this controversial research that has captured the imagination of the educators? As a result of his ingenious experiments with animals and humans, Sperry, the guru of the popular press and the right-brain advocates, was able to show that each brain hemisphere evolved its own specialized mode of information processing. The left hemisphere has become synonomous with verbal, sequential, mathematical, temporal and logical functions, while the right is described as wholistic, synthetic, creative and intuitive. In a healthy brain, the hemispheres usually complement each other. However, in cases where the major commissure, the corpus callosum (a bundle of axons and important "communications link" connecting the hemispheres), was severed to alleviate symptoms of epilepsy, Sperry and his co-workers showed that each hemisphere had its own capacity for learning, emoting, thinking and acting. A commissurotomy (severing of the corpus callosum) resulted in some respects in a "split personality", whereby one side of the brain did not know what the other was doing and perceiving. Man's language function has necessitated the evolution of a unique and dominant left brain, which is an important determinant for his perception of the world and his consequent behavior. Despite Sperry's reputation for stressing laterality and for supporting the development of the right hemisphere in education, he also refers to the complexity of the brain and the necessity of utilizing both hemispheres in complex cognitive functions, such as problem solving. This aspect of his research is rarely given prominence by the right-brain advocates.

Other researchers both expanded upon and questioned Sperry's conclusions. Broadbent emphasizes that the two hemispheres fulfil different parts of an integrated performance, not completely separate and parallel functions (Jerison, 1977). For example, imagery, which is essential for certain types of learning to occur, utilizes both parts of the brain because it is intimately connected with spatial and language functions. In addition, Jerison believes that language-related functions are so crucial to human performance that a nonverbal test of intelligence may be a contradiction in terms. Bogen also believes that no language or spatial functions are strictly lateralized and that particularly in the case of left hemisphere damage in the young child, other parts of the brain assume this function (Gazzaniga, 1977).

Gazzaniga emphasized that with an intact callosum the normal-brain subject can switch between the various modes of consciousness and that transfer of sensory or other information is particularly facilitated by language. Man's language capacity permits very sophisticated kinds of coding to occur and is essential for the operation of his complex mental processes on both the verbal and nonverbal levels. A particular experience has multiple aspects to it and these are coded and stored in many cerebral memory banks that may or may not communicate with each other. Gazzaniga and LeDoux (1979) suggest that there are multiple mental systems (emotional, motivational, perceptual, etc.), each possessing its own response probabilities. With the use of language, man is able to control and arbitrate between these systems and create a sense of conscious reality from them. These studies all suggest that it is erroneous to claim that one should or even can "shut off" one hemisphere to favor the other, as suggested by some teachers.

Many other interesting studies have been conducted regarding laterality in language functions (Krashen, 1977). Although in most cases the left hemisphere is dominant for language, many studies also show that language is an extremely complex function which utilizes both sides of the brain in varying degrees. Dichotic listening studies (i.e. one ear would hear "2", the other "4") such as those employed by Kimura (Krashen, 1977, 109-110) indicate that both hemispheres are used in language decoding. The Haskin (Krashen 1977, 111-113) Hypothesis states that the left hemisphere has considerable advantage in deciphering the most encoded sounds, for example the stop consonants, whereas the right hemisphere has the advantage with the least encoded sounds, for example the vowels. Because of the temporal element, the left hemisphere is better able to decode grammatical structure. Furthermore, not all languages are equally lateralized in the left brain. English is more left-lateralized because of the importance of the temporal element (Krashen 1977, 117-118). Considerable individual differences exist in the amount and time of lateralization, particularly in some left-handers and in women. One-third of left-handers have right brain dominance for language. Women have less specialized brains than men Krahsen 1977, 118-121). The conclusion that can be drawn from these studies is that lateralization and specialization are not as pronounced as previously believed.

Wittrock (1977) conducted rather eclectic research which should be of particular interest to teachers. He says that reading is a much more complicated process than previously assumed, and he traces many reading problems to brain dysfunctions. He stresses that the most powerful memory traces occur when imagery is combined with language, which means that both hemispheres are being stimulated, preferably on several levels. Inductive learning occurs mostly in the right hemisphere while deductive occurs in the left. Wittrock also has several important recommendations for instructional design. It should utilize multiple modes, not merely the learner's dominant mode or learning style. Like Winn (1982), he says that a lesson should be designed in terms of the types of processing of information that it stimulates. Teachers must devise new ways to facilitate the multiple processing systems of the brain, not just concentrate on developing the "neglected" right hemisphere. Perhaps one could conclude that the educational system is not properly developing the potential of either half of the brain.

Summing Up

The volume and complexity of brain research is overwhelming, yet it is but a modest prophet of the future. Our entire educational philosophy could change once this research is augmented and properly understood. The whole question is much broader than mere hemisphericity.

It is the writer's opinion that the present research, particularly that done by Sperry, has been over-simplified, misunderstood, and even abused by some educators. An earlier review of this research for educational technologists (Hellige, 1980) sounded a similar warning. It is dangerous to draw conclusions from the abnormal and apply them to the normal because there could be a significant qualitative and quantitative difference in brain functioning between them. We need all of the brain and must educate the whole brain, not half of the brain, if we are to function as human beings.

Our society needs to tolerate and encourage the development of many creative people who have the proper attitude and the skills to keep abreast of and go beyond the frontiers of knowledge. Creative learning requires creative teaching, but teachers need to "ally enthusiasm with discrimination in assessing the claims of new ideas and methods," (Lytton, 1971, p. 115). Nonetheless, there is a pressing need to develop future oriented, adaptive and intelligent thinkers, not mere conformists. The very survival of our species may depend upon it.

An Alternative Model

Beyond the excessive enthusiasm for and unwarranted application of the "split brain" metaphor by educators, there is another problem. The model totally ignores a large portion of what the brain contributes to human thinking and behavior. The cognitive functions that are differentially performed by the two hemispheres, and which form the basis for educators' interest in "split brain" research, are essentially to do with the way information is coded. The important functions of arousal and planning are omitted.

A more satisfactory metaphor for directing educators, and more especially instructional designers, is "front brain versus back brain" rather than "left versus right hemisphere". Such an approach owes a lot to the research of the Russian neuropsychologist Luria (1966, 1970, 1973), and to Western researchers who have developed Luria's model into an elegant theory of intelligence and cognition (cf. Das, Kirby and Jarman, 1975, 1979). The basis of Luria's theory lies in three blocks of the brain to do with arousal, coding and planning. While these blocks are located approximately in the back, middle and front of the brain, Luria makes the point of stressing their function rather than their location, and indeed refers to them as "functional systems", whose components may in fact be relatively scattered within the brain. Each block of the brain is made up of three sections which Luria calls "zones". These three zones are hierarchically arranged. The primary zones, labelled the "projsection zones", are responsible for reception and sending of nerve impulses. The secondary zones are where information is processed, and are concerned with the association of information derived from different senses by way of the primary zones. The tertiary zones are where information derived from the lower zones overlaps completely. These are where the efforts of many areas of the brain are integrated, and where the most complex of human thoughts and behaviors originate.

It is worth mentioning that Luria does not address the topic of creativity. This is perhaps because any emphasis on individuality would be somewhat unpalatable in a Marxist milieu. Nonetheless, his "whole brain" concept is very much in accordance with some of the explanations of creativity and brain functioning in general which are propounded by researchers from democratic traditions.

The functional system to do with arousal is located in the subcortex and the brain stem. It has primary responsibility for maintaining "cortical tone" (Luria, 1973, p. 44), and for autonomic processes like excitation and inhibition. Of particular importance to this functional system is the orienting reflex and its role in controlling attention. Possible implications for education and instructional design of research on the role of the orienting reflex and arousal in attention will be discussed presently.

The second functional system has to do with the coding of information. It is located in the lateral regions of the neocortex. Like the first block, this block of the brain is divided into three zones that are organized hierarchically. The first zone is involved in the reception and initial analysis of information into its basic components. It is sensory modality specific. The second zone organizes the information further by relating information across sensory modalities. The third zone is amodal and performs higher order analysis. With increasing amodality comes increasing functional lateralization (which is where, of course, "split brain" research fits into Luria's model). Information may be processed either simultaneously or successively in each zone.

The third functional system has to do with planning and decision-making, and is located in the anterior regions of the cortex. The primary zones of this block of the brain are to be found in the motor cortex, and serve as the outlet channel for behavior arising from decision-making. The secondary zones consist of the premotor areas of the cortex, and are concerned with the preparation of "programs" to direct behavior. The tertiary zones are in the prefrontal lobes. They are concerned with the formation of intentions and with the regulation and verification of the most complex forms of human behavior. Intelligent behavior involves far more than just coding. It involves coding with a purpose (Das and Jarman, 1981) so that intellectual responses meeting the needs of the particular person are arrived at. The notion of learners planning the way in which they will learn is closely related to current ideas about learning strategy and metacognitive ability, which have important implications for the design of instruction.

It can be seen that Luria's model offers a much more complete account of learning than the "split brain" model. Hemispheric assymetry fits into the second functional system, and involves at most two out of the three zones that operate in this block of the brain. The implications of this limited, as well as erroneous concern on the part of educators, will become evident as the implications of Luria's model for instructional design are examined. Though it too is only useful as a metaphor, it is nonetheless a more complete one. We will now look at each block of the brain in turn. We begin with arousal and its role in attention. This is also the one area where it is safe to talk about neurophysiological processes and their links to learning.

Arousal

Consider attention. For the teacher, it appears too often to be absent. For instructional designers, attention is something we intuitively appeal to through format, pictures, unusual captions, and bold print. We believe it should be got, grabbed and paid. But what is it really? In fact, attention is a marvelously complex physiological system lodged in the more primitive parts of our brains. It results from a sensitive interplay amongst brain systems. Attention manifests itself subtly throughout the whole human body in blood volume, in sweat gland activity, in heart rate and in pupil size. Its affect on learning is at once profound and telling. It occurs unmonitored and automatically in the interplay of two processes, arousal and orienting. Arousal is general; orienting is somewhat more specific -- it is the group of physiological processes that are the onset of learning. If these processes seem abstruse, it is because highly sophisticated disciplines, neurology, neurophysiology, and psychophysiology have arisen to explain and explore this phenomenon.

Arousal and orienting appear to occur in two separate though neurally connected brain subsystems: the reticular system and the limbic system. The first, arousal, refers to the neural tone or general excitation that the person demonstrates at any particular moment. Four characteristics of the reticular system are pertinent:

A. The system is general rather than local. It functions to excite or inhibit an extended neural pathway that runs from the brainstem to the cortex, and affects the entire body (Ingram, 1976). Concomitant to this is the fact that arousal is a long latency or long duration response.

B. The system is responsive to a variety of sensory modalities. Anatomically, the reticular system receives collateral neurons from various sense organs on its ascending pathway (Thatcher and John, 1977). The process of coding occurs simultaneously with arousal. The transmission providing sense data spreads throughout the reticular system. Instructors are well aware that drowsiness or extreme excitation, such as anxiety, attenuates coding. And the stimuli must be altered, for example a stern word or a quiet reading time, to aid learning.

C. The reticular system receives feedback from the cortex particularly the frontal lobes (Luria, 1973). So arousal may be affected by expectancies or plans such as making a speech or going into battle.

D. The system inhibits some brain sites and excites others. Arousal, therefore, is not simply a matter of the quantity of nerve transmission, but rather the qualitative brain state that the organism displays as a result of the neural transmission whether it be alertness, sleep, or extreme anxiety. Alpha states, for example, appear to be a function of arousal, and may be desirable prior to learning.

To recapitulate, arousal is a generalized, long latency process that is both non-specific and modifiable by higher order processing; arousal results in differing brain states. It is the sine qua non for both the coding and planning functional systems.

In contrast, the orienting reflex is a phasic or short latency response that is superimposed upon the general tonic state of the organism. It might be visualized as occuring on top of or added to the arousal state, like an extra jolt of nervous stimulation that piques us. This phenomenon was first named by Pavlov in 1927 who noticed that only stimuli that provided an observable attentional reaction before conditioning could be effective as a conditional stimulus. Thus, a bell provoked an attentional reaction from his dogs, and therefore could be successfully paired with food for conditioning. The orienting reflex was posited to be a sensitizing process initiating cognitive functions like visual perception, problem solving and remembering.

Research suggests that the likely brain site responsible for the orienting reflex is the hippocampus, a cluster of relay cells in the limbic system. The limbic system, like the reticular system, is a functional brain circuit. It is situated in the midbrain and forebrain. (It is also called the "reptilian brain"). It addition to being the likely site of the orienting reflex, the limbic system has been shown to affect emotional states such as rage, sexual arousal, and pleasure Olds, 1969). We are all aware that the perception of logical patterns in the universe, such as understanding a law of physics, can be highly pleasurable. Similarly, learning may be burdened with anxiety, such as the need to pass exams or to gain approval.

Numerous researchers have implicated the hippocampus with the onset of the memory trace (Berger & Thompson, 1978; Luria, 1976; McGough and Gold, 1976; Milner, 1972; Pribram and McGuiness, 1975). Berry and Thompson (1978) conclude that hippocampal activity is "completely predictive" of behavioral learning, and in its absence learning does not occur. Arousal is necessary to establish a brain state conducive to learning, but not sufficient in itself to initiate learning. A superimposed attentional reaction is also necessary to initiate the memory trace.

The orienting reflex not only occurs centrally in the limbic system, but also occurs peripherally along the stimulus-response pathways of the autonomic nervous system. It is most commonly and reliably measured in the skin conductance response (SCR) in such an unlikely anatomical structure as the sweat glands of the palm

(Lockhart and Lieberman, 1979; Grings, 1979). Other measures which behave idiosyncratically, but have nevertheless been implicated in the orienting reflex, are heart-rate (Lacey and Lacey, 1974), vasomotor changes (blood volume) (Skolnick, Walrath and Stein, 1979), and pupillary changes (Kahneman, 1973).

The orienting reflex, then, is an automatic physiological response, signalling neural activity, and is measurable throughout the body. Since the orienting reflex is a response to learning, it should occur reliably when stimulus characteristics associated with learning are present. This is in fact the case. Research shows differential orienting reflex onset to the following stimulus characteristics (Van Olst, Heemstra & ten Kortenaar, 1979):

A. Sensory determinants.
    1. Intensity of the signal.
    2. Temporality. In other words, the pairing of action and consequence through time.

B. Structural determinants.
    1. Complexity, for example the presentation of musical harmonies rather than single repeated tones.
    2. Informational value.
        i. The orienting reflex occurs in direct relation to the quantity of information. The greater the quantity of information, the greater the response (Bernstein & Taylor, 1979).
        ii. The orienting reflex occurs in conditions of relative novelty. However, it does not occur in circumstances of complete novelty (Blakemore, 1974).

C. Signal value, for example verbal conditioning to certain words, such as one's own name, provoke an orienting response (Kahneman, 1973).

The response satisfies the condition that occurs when the stimulus is informational. Furthermore, Graham (1979) has demonstrated that the orienting reflex is a different reaction than either the startle or defence reflexes. Tikhomirov and Vinogradova (1970) have demonstrated the presence of the reflex in more complex tasks, when they showed it occurs reliably and prior to the ability to verbalize, and in the successful solving of chess problems. Corteen (1969) found that the level of skin conductance orienting response predicts long term recall, and Kintsch (1965) found that the orienting reflex is maximal on the last error before learning.

The orienting reflex demonstrates two further characteristics that support the evidence that it is indeed a physiological response to learning. First, it habituates. This means that repeated stimulation results in a decrease in response. Extended periods of stimulation without any contingency (matching of stimulus with reward) result in relatively permanent decreases in response. For example, the sound of airplanes taking off would probably provoke an orienting reflex in a novice passenger, but would not in an airline stewardess. Habituation is therefore one of the chief adaptive mechanisms that organisms have to filter out insignificant stimuli. Similarly, in an instructional setting, a student may filter out insignificant stimuli in order to accomplish a task. On the other hand, the student may fail to respond to instructionally significant stimuli because other stimuli are more significant to the student, or because of an attentional or perceptual disability like hyperactivity.

However, if the stimulus is significant, then the orienting reflex does not habituate. Rather, it maintains sensitization over the period for learning the contingency. Pendery and Maltzman (1977) and Maltzman (1980) have demonstrated that if subjects discovered then verbalized the contingency, their skin conductance response did not habituate, but they continued to orient throughout the stimulus sequence. In contrast, the orienting reflex in those subjects who did not discover the contingency habituated to base level. In this experiment, the contigency condition was the pairing of the word "plant" to an audible tone. These results paralleled those in a second set of subjects. In this case, the subjects were divided into two groups. One group was instructed to listen for the critical word "plant"; the others were given a filler word for which the contingecy did not hold. The former group maintained their skin conductance response while the response in the latter habituated. Thus the instructor must ensure that there is sufficient positive feedback so that the learner does not habituate with the result that he or she gives reponses that are chronically depressed. This is the so-called "turned-off" learner.

These results indicate that the orienting response continues in the individual who discovers a meaningful contingency. But sensitization *per se* is not learning. What happens to the orienting reflex in cases where conditioning occurs? Grings (1979) has studied the form of the skin conductance response in the case where the contingency is recognized. He has shown that the initial orienting reflex becomes chained to the conditioned response. Thus, the orienting reflex is integrated into a response complex, and the organism incorporates a new behavior into its repertoire. The suggestion is that human learning depends upon the function of a lower brain mechanism, the reticular system, to maintain arousal, and a midbrain mechanism, the hippocampus, to potentiate the system for information processing and memory trace storage. Whatever differentially affects the performance of these two subsystems should differentially affect the traditional dependent variables of instruction -- learning time and achievement.

Do individual differences appear in this interdependent complex of brain state and orienting? This is an index of the sensitivity of the processes. If reliable differences appear in achievement due to a variety of aptitude differences, will these be reflected in significant correlates with orienting reflex differences? This suggestion is in some measure borne out by research. There is a positive relationship between the orienting reflex magnitude and conditionability (Furedy & Schiffman, 1974). Deboskey, Kimmel and Kimmel (1979) have found that gifted children, as measured by the Stanford-Binet test, have significantly higher skin conductance orienting response magnitudes and significantly slower habituation rates than those of average students. These differences are in the same direction as those found previously in comparisons between average and slow students. Zeiner (1979) found orienting reflex magnitude to be a significant predictor of grade point average. These results warrant an extension of our confidence in the measure of the orienting reflex to predict not only subjective probability and informational values of stimuli, but also to predict capability.

Physiological measures, like the orienting reflex, show promise because the research results warrant our consideration of these measures as they might interact with task performance. Nonetheless the measure is still not well enough understood. First, it is not sufficiently fine, nor is the research community sufficiently clear as to what it is measuring. Second, a theory establishing the physiological component of instructional tasks does not exist. Finally, a cost-effective, convenient mechanism by which physiological feedback might be put into instructional procedures is not in place.

However, there are numerous hypotheses that might be advanced. For example, in applied research Eysenck and White (1964) and Eysenck (1967) suggest that factors of temperament, particularly introversion-extroversion, interact with intelligence in a curvilinear relationship. Eysenck follows the argument advanced by Kleinsmith and Kaplan (1963) that strength of arousal relates directly to the strength of memory consolidation, that is the transfer of memory traces to long-term storage. However, the potentiation process in the limbic system interferes with further recall, particularly in the highly aroused subject. Therefore this person is at a disadvantage over short recall periods, while performance is superior over longer periods. Introverts are presumably characterized by high arousal, high potentiation and high short-term interference, extroverts by low arousal, low potentiation and low short-term interference, and therefore performance for both groups should vary in time. Although introversion-extroversion may be a poor choice of predictor, Orlbeke and Feij (1979) suggest the possibility of maximizing performance by manipulating information presentation times as a function of orienting reflex measures. This might be especially effective in subjects with hypo- and hyperactive attentional disorders who show highly significant variances in basal levels of arousal (Williams and Das, 1979).

This is but one of many potential applications. Others might include the variability in maintenance of persistence, which according to Eysenck is a factor in intelligence, as a function of orienting reflex habituation rates (an extension of some earlier research by Pendery and Maltzman, 1977); the ability to monitor one's own brain waves and thereby improve task performance (Donchin & Israel, 1980); and the possibility of learning rote material in low arousal states.

It is likely that from the understanding of events intervening between instruction and performance will emerge an enrichment of explanation and an enhancement in the effect of instructional treatment. The interaction between motivational and emotional states and performance criteria will undoubtedly be clarified. There is the promise of new instructional configurations in which physiological information is fed into a matrix of instructional options.

Coding

The discussion of the functional system to do with coding will deal with two matters: the relationship between coding and the modality in which information is presented to the learner; the roles of simultaneous and successive processing. These two issues have been selected from the many that surround the question of coding because they, above all others, have a direct bearing on what it is instructional designers do, especially those who work with audio-visual media for the presentation of information.

As we said above, the block of the brain to do with coding is divided into three zones (Luria 1970, 1973). The primary zones are responsible for "elementary registration and analysis" (Das and Jarman, 1981), where information is first picked up and some attempt is made to sort it out. They are modality-specific. The secondary zones serve to relate information across modalities, and are therefore less modality-specific. The tertiary zones are responsible for even higher-order processing of information regardless of modality. The result is that as information is coded, it moves from one zone to another, each of which is less modality specific than the preceding one. At the same time, the original form in which that information was coded by the learner becomes less important as far as the meaning of the information itself is concerned. It is interesting to note, as Das and Jarman have pointed out (1981), that Luria's theory of zones, each with a different degree of reliance on sensory modality, encompasses just about all theories of sensory modality that are evident today, from those that hold that modality has an important impact on cognition, to those claiming that modality is irrelevant. Das and Jarman go on to suggest that the degree to which sensory modality is important in information processing and learning is probably not simply a matter of choosing from among theoretical positions, but is rather a question that involves many factors, including information load (Freides, 1974), task (Winn, 1982), and the type of learner (O'Connor and Hermelin, 1978).

The notion that the further information is coded, the less it depends upon the form in which it was presented will come as no surprize to those of us who are familiar with research concerning "depth of processing" (Craik and Lockhart, 1972). There is a great deal of research from cognitive psychology, in addition to the neurological evidence, that the more information is processed, the more abstract the way it is represented in memory becomes (see Winn, 1980 for a summary of this research). Indeed, scholars who take the side of the proposition in the image versus proposition debate (Pylyshyn, 1973, 1981; Anderson, 1978) are tacitly subscribing to this point of view, since a proposition describes very few, if any, details of the form in which the information was presented.

What is perhaps less well known is research that relates modality specificity in information processing to intelligence. In a study by Jarman (in press a), subjects performed either intra-modal or cross-modal matching of auditory and visual stimuli. Materials consisted of patterns of either dots in sequence on the page (visual-spatial), flashes of a light (visual-temporal), or tones (auditory temporal). For the cross-modal task, subjects were given a stimulus in one modality, and a pattern to compare it to in another, and had to say if they were the same. For the intra-modal task, both the patterns were presented in the same modality. This gave a total of nine possible combinations (visual-temporal, visual-spatial and auditory-temporal for both stimulus and comparison patterns). Subjects were placed into two groups, those of above average intelligence and those of below average intelligence. A repeated measures design was used. The nine scores for each subject were factor analyzed. While the results of this analysis are quite complex, the factors that emerged for each group were different. For the low intelligence group, factors were defined in terms of the modality of the stimulus. This effect was far less marked for the high intelligence group. The conclusion that can be drawn is that stimulus modality is something that plays an important role in the information processing and learning of students of low intelligence, but that it plays less of a role with more intelligent learners.

To return to Luria's theory for a moment, the results of this study suggest that more able learners will code information in those zones of the brain where processing takes place in such a way that modality has little relevance. In other words, a feature of intelligent coding might be the ability to divest information of its surface forms, to integrate it, and to manipulate it in abstract forms such as propositions. One might even go so far as to suggest that the media designer's preoccupation with communication channel (the audio and the visual) is irrelevant to intelligent behavior, and serves to distract less able learners from the content of instructional messages by drawing attention to their form.

At the same time as information becomes less modality specific, the functions of the brain become increasingly lateralized. This is especially true for the secondary and tertiary zones. What this means is that the primary zones have identical functions in both hemispheres. However, as the information moves from the primary to the secondary and tertiary zones, and becomes less modality specific, it is processed according to the different functions of the two hemispheres, which were described earlier in this paper. In other words, association and synthesis of various pieces of information can be carried out differentially by either of the two hemispheres. What this means is that cerebral assymetry does not exist at the level of initial decoding, which is modality specific, but at a functional level which is independent of modality. The implication, of course, is that the hemisphere that processes the information has nothing to do with the form in which the information was first perceived and decoded. So making information (or a curriculum) more "visual" will not necessarily do any more to develop the right hemisphere than any of a number of other things. Indeed, making instruction more verbal might do more to "develop the right hemisphere", provided that the student associated and synthesized that information (secondary and tertiary zone functions) in a parallel, wholistic, rather than serial manner. And as we shall see, parallel (simultaneous) processing is extremely important in the comprehension of textual material.

The second area of interest in the functional system to do with coding involves the way in which information is processed. Both Luria (1966, 1970), and Das and his associates (1975, 1979, 1981) propose that humans can process information in two ways, simultaneously or successively. Both involve the synthesis of information perceived sequentially into meaningful aggregates. Indeed, all information is initially encoded as sequences. In reading text, of course, this is obvious. One word follows another, as do sentences and paragraphs. However, even when looking at pictures, which are traditionally thought of as presenting information "wholistically", information is encountered one piece at a time in sequences. That this is in fact so has been shown time and again by research into eye movements, where people are seen to scan visuals (and indeed the real world) in a series of fixations and jumps from one fixation to the next (Yarbus, 1967; Just and Carpenter, 1976). Yet somehow this information is synthesized into meaningful units in the second block of the brain for storage in memory. It is how this synthesis takes place that is described by the theory of simultaneous and succesive processing.

When simultaneous synthesis takes place, all of the information that has been coded so far is available to the learner in short term memory at once. The best analogy to describe this is probably doing a jigsaw puzzle. Here, a person can only place the next piece if the puzzle as it has been completed up to that point is visible. No sequence is required for placing each piece. In successive processing, the aggregate of the information is not surveyable by the learner. An appropriate analogy is threading beads on a string. Each bead occurs in a fixed position in the sequence, and provided its neighbors are known, there is no need to know the position of the bead to every other bead on the string. Clearly, simultaneous processing has spatial overtones, and successive processing has to do with sequential cognitive processes. However, simultaneous and successive synthesis do not have discrete relationships with traditonal learning tasks, as we might expect. For instance, research has shown (Kirby and Das, 1977; Cummins and Das, 1977) that reading involves both of these processes. Indeed, the more complex a text, the more simultaneous processing plays a role, because more information has to be surveyable at one time by the learner if meaning is to be derived from complex texts. Luria (1966) claims that simultaneous synthesis is involved in learning linguistic and numerical skills, while successive processing occurs when skilled movements, such as writing and narrative speech, are undertaken.

Das and his colleagues (Das et. al. 1975, 1979) propose that simultaneous and successive processing operate in the brain at three levels, roughly paralleling the three zones within the second functional system. At the perceptual level, the two processes operate on perceptual stimuli that are being received at the time. Information from the environment is received through a learner's sensory systems, and is organized either simultaneously or successively. At the mnestic level, information is synthesized either simultaneously or successively from memory. At the intellectual level, complex systems of the relationships among concepts are constructed, usually simultaneously. Das, Kirby and Jarman (1975) claim that this is necessary for the comprehension of complex ideas. It is therefore important to note that simultaneous and successive synthesis are cognitive processes that have to do with more than sensory input. They are processes that operate at perceptual and at higher intellectual levels.

Research has shown that simultaneous and successive processes are activated in learners by the demands of particular learning tasks, as well as being related to learners' mental skills and styles. It has been reported (Winn, 1982) that learning tasks interact with simultaneous and successive processing in such a way that the appropriateness of each type of synthesis for particular tasks can be identified. Likewise, tasks requiring varying degrees of skill in each type of process interact with learner ability in simultaneous and successive processing ability, assessed by such tests as figure copying (simultaneous) and digit span (successive).

As far as coding is concerned, then, the research of Luria, and of Das and his associates has provided some information that has implications for instructional design that are very different from those derived from split-brain research. These have to do both with the way processing is related to sensory modality and to the two forms of simultaneous and successive processing. Rather than simply concluding that we have to "develop" the right half of the brain (whatever that means), we are led to rather specific conclusions about the way the functional system to do with encoding handles information. First, we have seen that the more information is processed (the "deeper" it is processed perhaps), the less relevant is the format in which that information was presented. Indeed, some researchers have even suggested that being able to get away from the modality of presentation is a sign of high intelligence! However, instructional designers in our area still seem to be preoccupied with media format and not with cognitive processes. This is clearly a mistake. The main function of the brain, in encoding as in other processes, is the integration of information across modalities. In addition, it appears that hemispheric specialization increases as modality specificity of processing decreases. Insofar as educators and instructional designers only have direct control over the form of information, and since how it is processed does not have much to do with form, then the idea that educators can control which half of the brain processes what is nonsensical, as is the belief that one hemisphere can be "developed" without the other. For example, drawing pictures stands no better chance of "developing" the right hemisphere than it does the left.

As far as processing is concerned, we have looked briefly at simultaneous and successive synthesis. We saw that these were not necessarily related directly to typical learning tasks, but that both processes tend to be involved to some degree or other in all learning. The types of synthesis are applied to perceptual information as well as to information in memory and to the synthesis of new and complex intellectual ideas. Once again, there is a message for instructional designers here. There is a tendency for designers to try to identify discrete skills that are related to learning tasks, while the research into simultaneous and successive processing suggests that these two processes, at least, are involved in all learning.

Planning

The greatest difficulty posed by the application of "split brain" research to education has been that the split-brain model is totally devoid of anything to do with what Luria has identified as "planning". The third block of the brain is a functional system concerned precisely with that. And it is again to the work of associates of Das that we must turn in order to look for evidence of this planning function (Das, 1980).

A study by Ashman (1978) succeeded in identifying a "planning" factor, as well as factors for simultaneous and successive processing. Ashman tested the hypothesis that the planning function could be measured by means of tasks that are commonly used to test frontal lobe functions. This hypothesis was based largely upon research showing that damage to the frontal lobes affects strategic thinking, foresight, and other types of planful behavior (Das, 1980; Eccles, 1977; Luria, 1973). The tests Ashman identified were a visual search task, a trail-making test, a test of verbal fluency, and planned composition. (These tests are described and referenced in Das, 1980, and Ashman, 1978, and will not be described further here.) Suffice it to say that each test requires the subject to decide either upon a strategy to follow or how coded information is to be used. Subjects took these tests as well as tests of simultaneous and successive processing (for instance, memory for designs and figure coyping for simultaneous and digit span and auditory serial recall for successive. See Das et. al. 1979 for descriptions of these tests). Scores from these tests were intercorrelated, and the resulting matrix factor analyzed. Principal components analysis with Varimax rotation revealed three factors, simultaneous, successive and planning, as predicted. The planning factor was marked by the four tests Ashman had selected from tests of frontal lobe functions. These results were obtained for grade eight students, for educable mentally retarded subjects, and for trainable mentally retarded subjects.

This study therefore suggests that planning is orthogonal to coding, which would seem to support Luria's model. However, there is a suggestion (Das, 1980; Luria, 1973) that the independence of planning and coding is developmental. Luria himself suggests that children may not have developed the planning functional system before the age of four or five. Das mentions research with deaf children which likewise suggests that a developmental dimension affects the separation of planning from coding.

This research is particularly interesting because it has a parallel in research in instructional psychology. We are, of course, referring to the question of metacognition, which has been addressed by a number of researchers (see Brown, Campione and Day, 1981; Lawson, 1980). While metacognition is a complex business, it is most simply described as knowledge of and regulation of one's own cognitive processes (Brown, 1981). Instructional designers, and instructors, have extended this notion of learners' "self-control" over learning (Landa, 1974), and have described ways in which learning strategies can be identified (Rigney, 1978; Bovy, 1981) and taught.

A study by Peterson, Swing, Braverman and Buss (1982) illustrates the role of awareness of cognitive processes in learning. Grade five and six students were taught a unit on probability, and the classes were videotaped. After the class, each student was interviewed, and the tape was used as a prompt as to what the student was thinking at the time. In general terms, what students reported they understood about the lesson was related to achievement. More interesting was the finding that students who reported using specific cognitive strategies, such as relating the information in the lesson to existing knowledge, achieved at a higher level. Moreover, the use of such strategies was positively related to ability measured by STEP and Raven's Progressive Matrices. These results suggest that students who are aware of their own cognitive processes can apply strategies effectively. This metacognitive skill appears to be related to general ability.

While this study demonstrated that awareness of cognitive processes is a useful metacognitive skill, it did not directly examine attempts to regulate processing by means of instructional strategies. Research in this area has generally found that, when instructed to do so, and especially when shown how to do so, students can regulate their own learning by the application of particular learning strategies to the instructional task. This has been demonstrated for learning information in maps (Thorndyke and Stasz, 1980), pattern recognition (Winn, 1982), and a number of other tasks. Typically, it is found that instructions to use strategies improves the performance of students over those who have not had such instruction, and that demonstration of the strategies leads to even greater improvement, especially for low-ability students (see Bovy, 1981). This research, combined with that showing that knowledge of one's own cognitive processes can improve learning, suggests that metacognition plays in psychological processes a role similar to the functional system to do with planning in the brain.

This leads to the question of whether learners can be trained to use and to plan the use of processes, such as simultaneous and successive synthesis, that have arisen out of brain research. Since people do not code information for its own sake, but code it for a purpose (Das and Jarman, 1981), it would seem that the answer to this has to be "yes". Fortunately, there is empirical evidence that backs this up. Krywaniuk (1974) worked with a group of grade three and four native Canadians. Over a period of time, they were trained in such tasks as arranging pictures into story sequences, constructing patterns from tiles, serial recall, cross-modal coding and the recall of numbers placed in matrices. The criterion measures were scores on a variety of tests. Comparison with pre- and posttest scores showed significant improvement on the Schonell Word Recognition test, on Visual Short-term Memory, and Serial Learning. This suggested that the training program had improved successive processing ability.

Kaufman (1978) likewise sought to train successive skills. Grade four subjets were trained in a number of tasks, some the same as those used by Krywaniuk, others including serial recall of pictures, free recall of pictures, and several variations of the matrix recall task, using letters and pictures as well as numbers. Comparisons of pre- and posttest scores showed significant differences on all of eight tests of simultaneous or successive processing. Comparison of an experimental and control group also showed significant differences for some of the tests. Again, the training appeared to have been successful.

What this research tells us is that planning processes are not the same as coding processes. The planning function of the brain is concerned with how coded information is to be put to use. There is little point in dealing with the coding function in isolation in instructional design. (Remember that the "split-brain" model is pretty much limited to coding.) As we have seen, planning, strategic behavior, or problem solving are skills that learners need to possess if they are to be able to do more than simply take in information. These skills must be born in mind by the instructional developer, whether the intention is to teach them by means of the instruction that is under development, or whether the learners already possess them. At the very least, instructional designers need to find out whether learners possess sufficient skill in planning in order to use the information they will encode to their advantage.

Conclusion

In this paper, we have looked at the problems of split-brain research and at Luria's more comprehensive three-block model of the brain. From our research, we conclude that Luria's model is a better metaphor for instructors and designers to follow. This is because it deals with arousal and planning as well as with coding, to which the split-brain model is generally limited. What also makes Luria's model attractive is the fact that a lot of good research, primarily by Das and his associates, into learning and human ability has identified psychological constructs that appear to be linked to Luria's "functional systems".

We suggest that it is more practical and profitable, given what we know now, for educators to use brain processes as simply a metaphor for instruction and design, rather than to seek guidance in neurological processes themselves. Except for parts of the first functional system we looked at, arousal with its relationship to attention in learning, the links between brain processes and human behavior are just not there. What this means for design is that instruction should aim to draw and hold learners' attention, to facilitate the coding and interpretation of information, and to indicate what cognitive strategies the learner should use. This is nothing new. However, what research based on Luria's model does tell us is the instruction should also attempt to: develop attentional processes so that the student is both aroused and oriented to the information that is given; develop coding processes so that information is processed independent of the modality in which it was presented; develop planning processes so that learners can decide for themselves how to best process information, for example simultaneously or successively. These processes will be developed through instructional rather than through physiological intervention.

In time, higher learning processes may be understood in terms of neurophysiology. At present, though, they are not. It is therefore misleading for us to believe that hemispheric research has anything to offer the instructor or designer beyond a metaphor. To develop curricula and to design instruction on the basis of processes that are not understood is foolhardy in the extreme. It is best to stick to what we know -- that is that learning requires attention, coding and planning, and that Luria's model serves as a reminder of this. Present research in cognitive and instructional psychology is dealing with similar constructs, and it is to these, not esoteric and half-understood theory, that we should direct attention.

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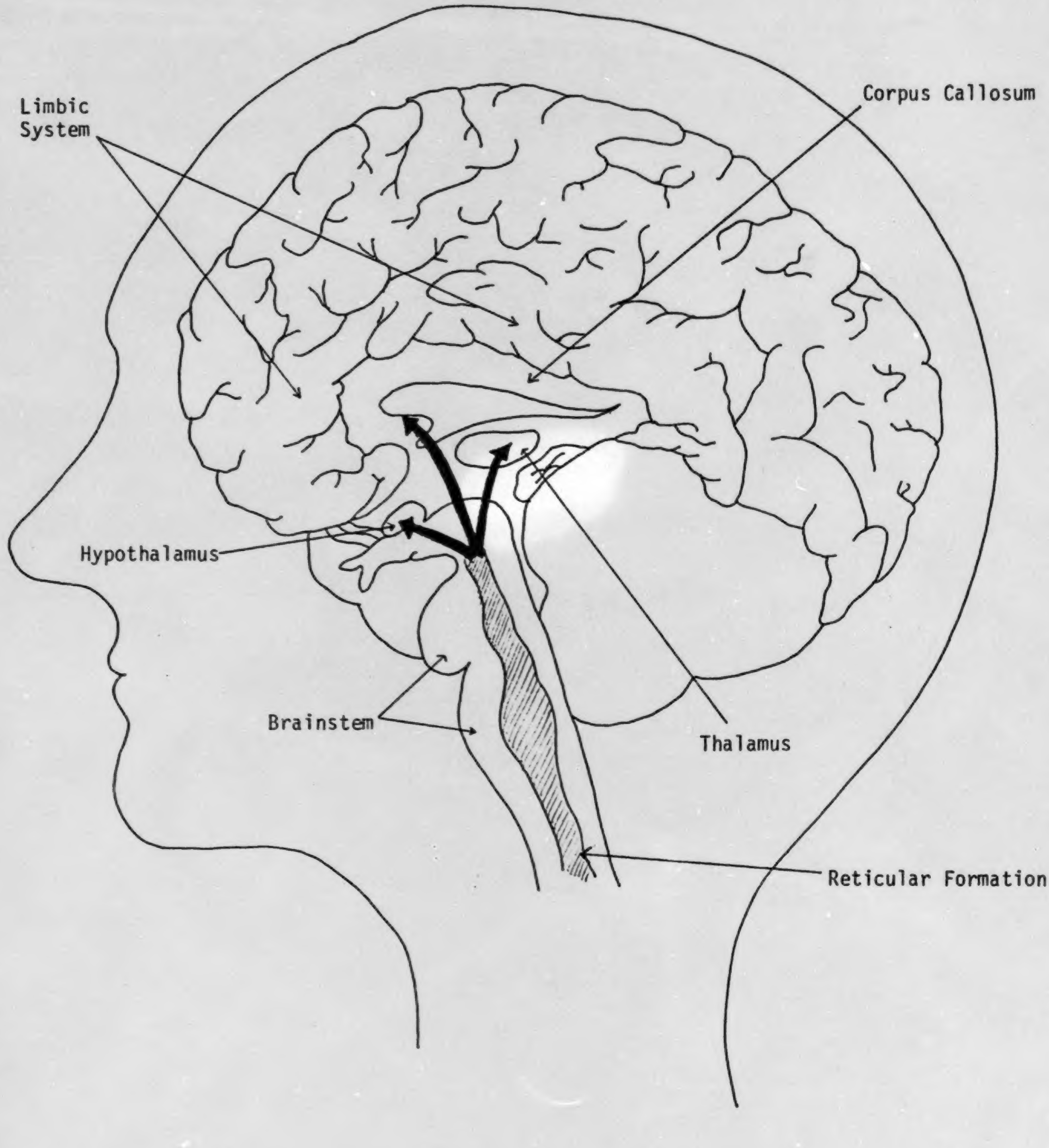
Midline View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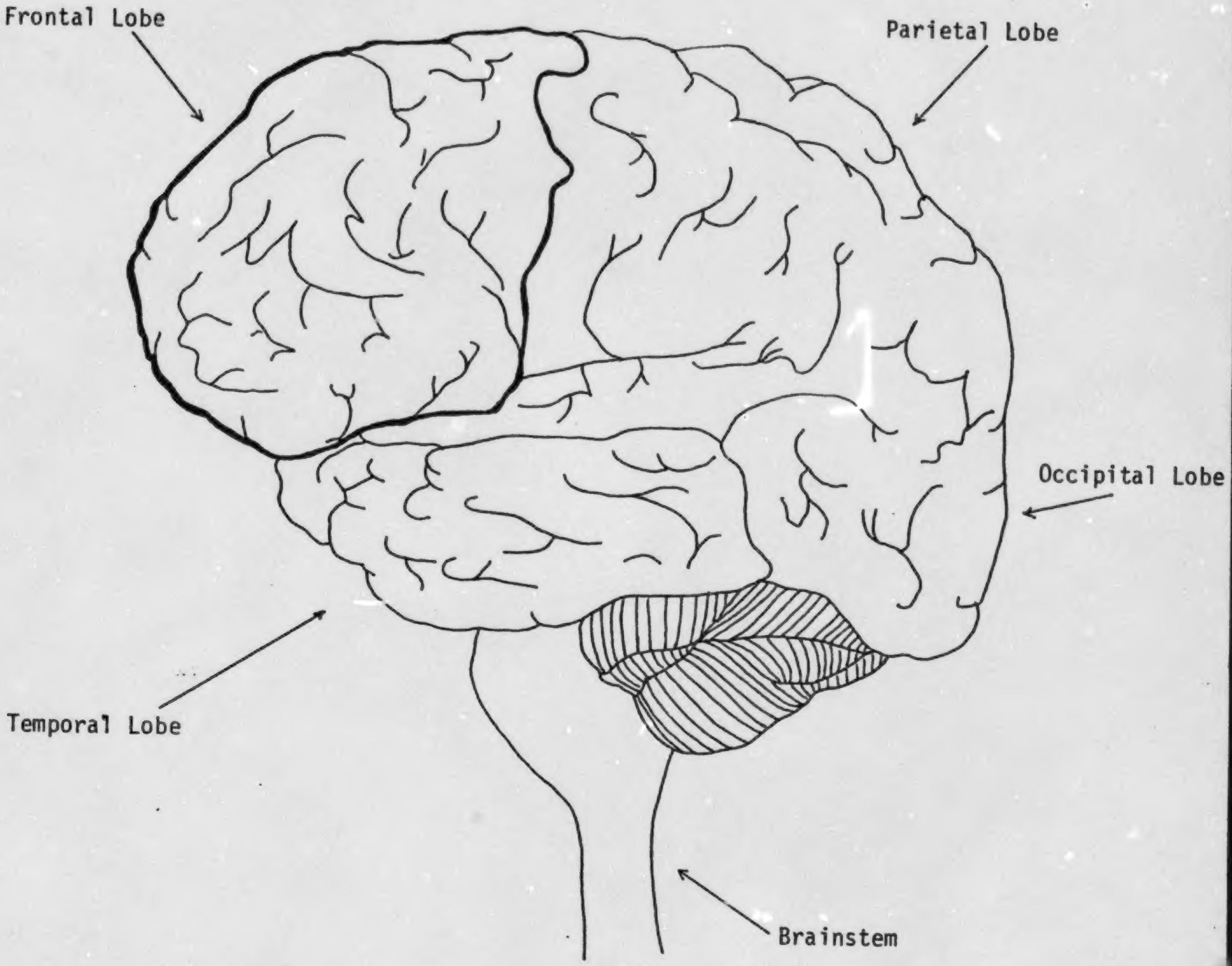
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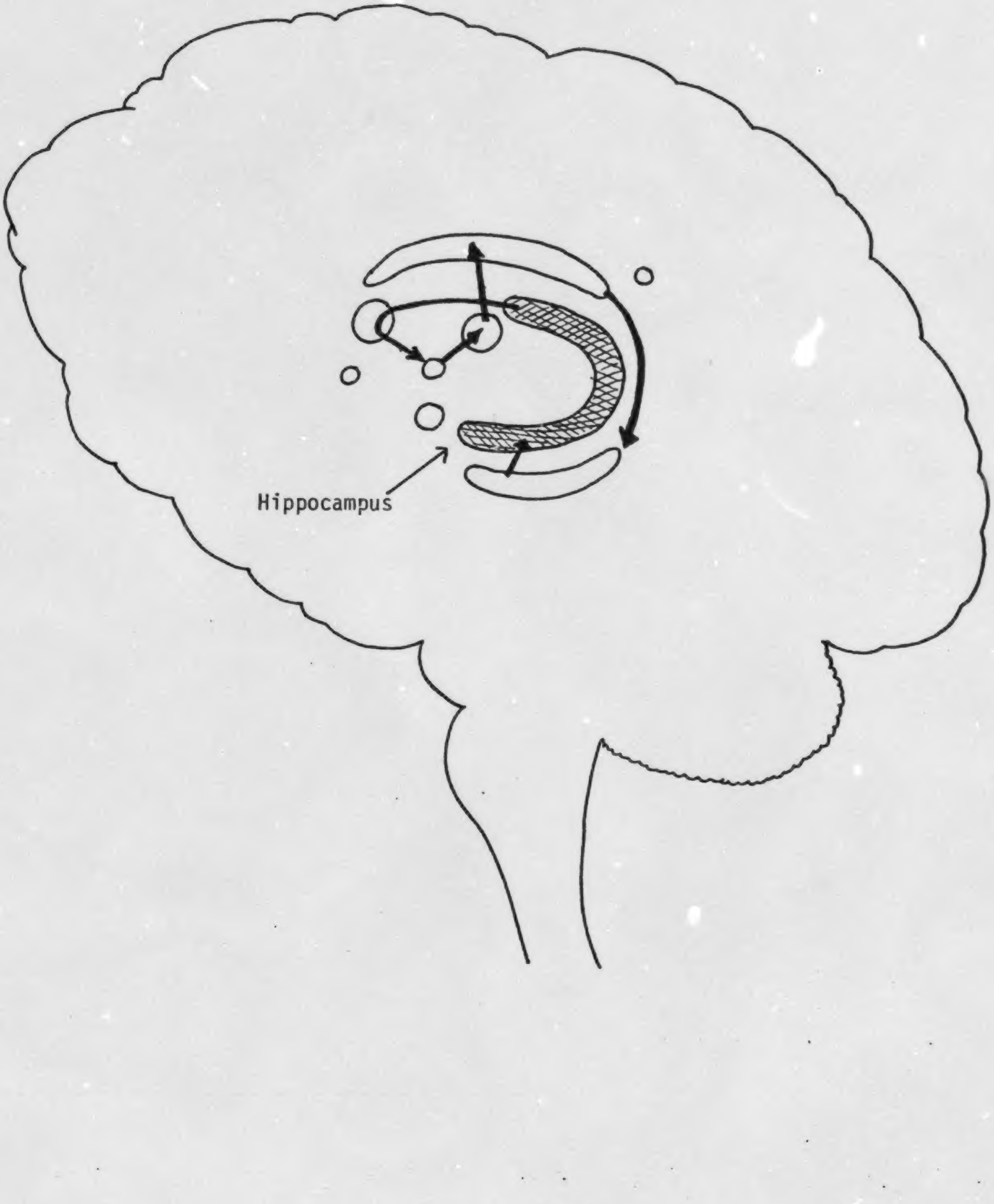
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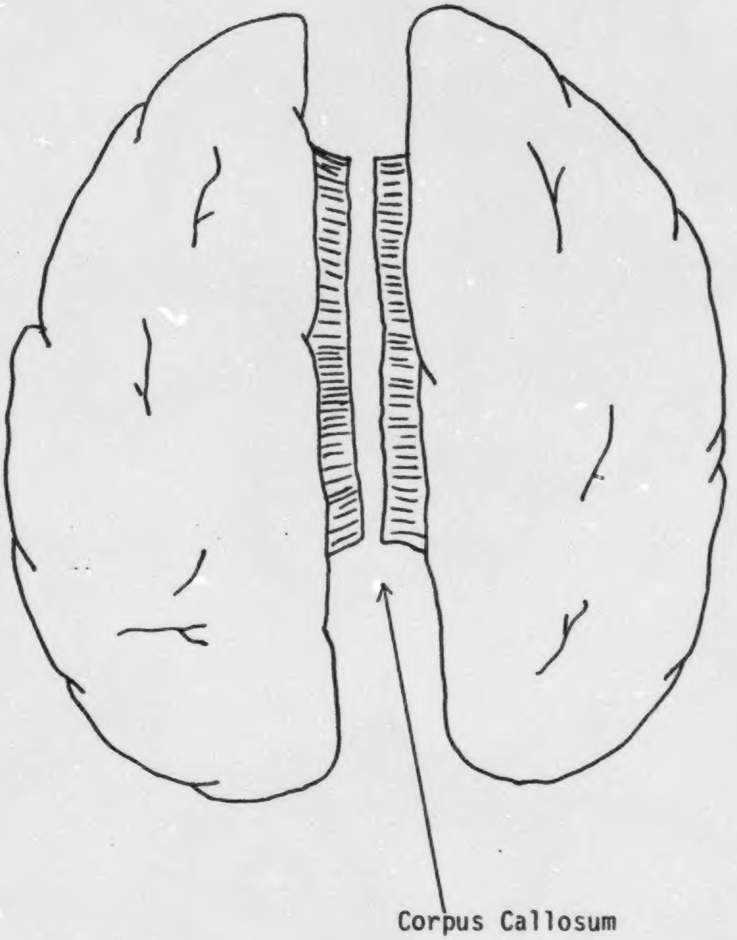
Corpus Callosum

TITLE: Moving In Americanese: The Nonverbal
Aspect of Communication

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MOVING IN AMERICANESE: THE NONVERBAL ASPECT OF COMMUNICATION

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A successful communicative act is an interaction among the linguistic, paralinguistic and nonlinguistic levels of language. The objectives of this presentation are to 1) define the basic concepts of nonverbal communication (NVC); 2) heighten the sensitivity of second language teachers, and especially ESL teachers, to the nonverbal aspects of language; and 3) to present activities designed to foster practical knowledge of NVC and classroom implementation of nonverbal learning techniques.

Basic Concepts of NVC

ESL and cross-cultural trainers, especially at the adult level, are concerned with helping their students acquire the skills necessary to communicate competently in diverse social and work situations. Communicative competence is defined as the ability to use the form of language appropriate to a given situation. Both the form and the function of the language should match. In other words, it is not sufficient to use the correct linguistic items in a grammatically correct utterance. The tone of voice, gestures, facial expressions and posture should also be appropriate to the situation. Thus, communicative competence, as used here, includes the nonverbal as well as the verbal modes of communication.

Communication within a culture allows people to be predictable. Without necessarily being conscious of it, human beings are constantly engaged in adjustments to the presence and activities of other human beings. A certain amount of predictability is required to make communication possible. NVC includes the unconscious consensus within a culture that allows basic predicatability and, thus, successful communication to occur; it is specific to a culture. There is considerable data attesting to its significance for the shaping of meaning in any interpersonal communication. However, the implications of this data have not been significantly extended to use in second language (L2) teaching and learning. There is a great desire and a great need for the integration of nonverbal learning strategies in multicultural and cross-cultural learning situations. (Davis).

Agreement is emerging that NVC serves a number of social functions including the display and recognition of emotion, the communication of interpersonal attitudes, and the regulation of the flow of social interaction. (Mayo & LaFrance). Verbal signals require cognitive processing; nonverbal signals operate directly, bypassing conscious analysis and evoking immediate response. Since information can be carried simultaneously on both verbal and nonverbal channels, "one is able to negotiate social relationships and supply emotional feedback nonverbally while exchanging information of a cognitive nature verbally." (Morain). Nonverbal reactions are especially prominent for the formation of attitudes since they tend to result from unconscious responses.

Movement is inextricably linked to meaning. Most people are unaware of the impressions their body language conveys to others. Yet, the information used in deciding what to do next results from response to the nonverbal cues of others - to their facial expressions, gestures, body movements, tone of voice, and so on. One reason for the impact of body language is the spontaneity of behavior. Although the words we use are chosen with care, we do not have as much control over our behaviors. We can monitor our language as we speak, and correct wrong choices, but we cannot or do not see ourselves as others see us. "There is no escape from

communicating, and there is no such thing as nonbehavior. We are always behaving, and others are always reading our behavior."
172. (Galloway).

Nonverbal aspects of communication increase in significance when verbal information is inadequate or missing. When words fail to convey meaning, or when verbal channels are minimal, a heavy load must be carried by the nonverbal channels. When verbal statements of thoughts and feelings are obstructed, then leakages and extra nonverbal information fill the void. Whenever there is a clash between what is conveyed verbally and what is conveyed nonverbally, it is the nonverbal that is believed.

There is considerable evidence confirming that crosscultural misunderstanding more often results not from what is said but rather from how it is said. In other words, communication fails when differences in the nonverbal signs and conventions are not understood across cultures. Bursack (1970) filmed Minneapolis men and women who deliberately tried to express "agreement" and "courtesy" nonverbally in an interview situation. The filmed sequences were studied by citizens of Beirut, Tokyo and Bogota. The viewers were unable to correctly interpret the Americans' attempts to communicate these feelings which are so critical in establishing a warm social climate in America. Thus, we cannot assume a common NVC system across cultures. Each culture has its own definition of what is predicatable in terms of time, space, gestures and expressions (Kuhlman). In multicultural communicative events misunderstandings often occur when the participants make incorrect inferences about the meanings of nonverbal signals.

Achieving communicative competence requires attending to others, responding to them appropriately, and knowing how one's response affects others. A person must learn when to display certain expressions; there are display rules in every culture that provide guidelines for the use of expressions and gestures. Successful communication occurs when the participants validate each other's messages and a consensus of context as well as meaning ensues.

If we assume that NVC is culture specific, what is the situation of the recent immigrant in the U.~S.~? Even if (s)he can speak and understand some English, (s)he may experience life here as if watching a film with L2 subtitles - the words and the gestures do not quite fit together to create cohesive and congruent expression because (s)he is interpreting the gestures according to his/her own cultural codes. Does (s)he understand American sarcasm? Irony? What are the appropriate codes for communicating successfully in this new culture?

Implications for Second Language Teaching

The ESL classroom process, with the teacher as the designer of that process, should facilitate the L2 learner's mastery of communicative competence. To determine how successfully this process is being implemented, 50 ESL teachers were interviewed. They were asked whether they thought NVC was important 1) in classroom interaction and 2) in helping students develop communicative competence. Three/fifths of the teachers interviewed did not deliberately integrate the nonverbal aspects into their ESL teaching. A number of these had never considered any relevance for NVC in L2 teaching/learning. Further investigation indicates that there is very little material available to the teacher which integrates NVC into L2 teaching/learning. (See bibliography).

Misunderstandings in the classroom often result when students and teachers misinterpret each other's nonverbal behaviors. The ESL student is the most likely to be seriously victimized by difficulties in communication. The forces of power, control, influence, motivation and self-esteem are related to nonverbal interactions. Both teacher and students interpret nonverbal dislays as reflecting inner feelings and attitudes. Inferences are drawn from these displays according to the individual's value system and are used to determine what to believe. The teacher is not only teaching language, but at the same time is teaching American values and codes; for example, communicating that in America this is the way we show approval, encouragement, disapproval, anger, etc. The student depends on correctly interpreting the teacher's nvb to sustain his/her own image. The student who misinterprets the teacher's nvb becomes confused, uncertain, embarassed or even angry and insulted.

Although the practical usefulness of nonverbal behavior in teaching is apparent, there is little systematic research on the relationship of teachers trained to integrate it into their teaching strategies and their students' academic performance. Research in teacher training still focuses largely on the verbal aspects of communication ignoring the fact that teacher expectations are conveyed nonverbally; that their values and attitudes are closely related to nonverbal behavior; that the majority of classroom communication is nonverbal and this is more potent than speech; that students are more responsive to facial expression and to gestures than to speech; and that empathy and warmth are better conveyed nonverbally that verbally.

ESL teachers generally stress academic skills to the exclusion of social skills. This is beginning to change with awareness of the need for "survival level" skills. However, even this beginning awareness of the L2 learner's need to develop social skills concentrates on verbal modes. We have found that ESL students (especially from the Far East) have considerable skill in manipulating English syntactical forms on paper. They are very good in reading and writing but lack listening and speaking fluency. Furthermore, they have a very low level of communicative competence. Classroom interactions are being developed which stress communication of thoughts, ideas and opinions rather than parrotting rote phrases. This encourages students to discuss their confusions about their new homeland, especially about nonverbal behaviors which differ, or appear to differ, from their own. For example, Reiko, a Japanese woman in an adult ESL class, was disconcerted because whenever she showed respect to Americans, they tended to respond in a manner she considered wholly inappropriate. Her show of respect consisted of a lowering of the body, head and eyes, a sign interpreted in America as one of shame or embarassment more than one of respect. When she learned of this interpretation, she was shocked and angry - why had she never learned this in an ESL class before? Why had she been allowed to embarass herself before the very people with whom she was trying so hard to become friends? The other students began to discuss events in their recent interactions which had caused confusion. They displayed a 'need' to know how to communicate fully with Americans - what reads and what does not.

Classroom Applications

This section of the paper has two parts: 1) the observation of a number of ESL and nonESL credit classes to study nv interactions between students and teacher and among the students; 2) to develop curriculum materials based on classroom observations. Some of the findings obtained from preliminary study of the videotapes indicate that:

a) ESL teachers tend to use more clarification mechanisms than do nonESL teachers;

b) those ESL teachers who are highly expressive nonverbally seem to elicit much active participation from the students; that is, the students interact a great deal with each other and with the teacher - the result is non-threatening to the student - the student is more self-confident and willing to try new language;

c) those ESL teachers who do not move around the class, do not use gestures, etc, to reinforce the verbal language, do not have strong interaction with the students - there seems to be less response from the students, more doubt and hesitation;

d) regular credit classes are conducted without special provision for the second language learners (they are expected to "keep up").

It is anticipated that the videotapes will be useful for in-service teacher training workshops as well as for diagnostic purposes. Students must learn to give nonverbal feedback in "Americanese"; teachers will become more sensitive to the nonverbal language of other cultures. Another outcome of the study will be to teach students who have developed linguistic fluency to use nonverbal cues to facilitate listening comprehension. Learning conventional NVB should enhance development of listening competence as well. When people lecture, they often use gestures to emphasize important information and to cue other aspects of the discourse.

As a result of the experience with Reiko described above, one of the authors integrated a "cross-cultural" sharing time into each class session. A sample of one of the activities is attached. In this class the teacher became the role model. The students were constantly asking "what does that movement mean?", often stopping the teacher in mid-sentence.

Second language learners need to learn about the give-and-take of conversation in the target language: mutuality, turn-taking, switching pauses, and timing. To know what to do when, students must become aware of what is appropriate to the situations and the culture in which they find themselves. It is difficult to function courteously and competently within a culture without participating actively in its basic rituals. Insights into posture, movement, gesture, facial expression, eye management and distancing not only increase sensitivity to other human beings, they also inevitably deepen the learner's self-awareness and knowledge of his/her own culturally determined kinesic system and code.

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